# SMOLT MONITORING AT THE HEAD OF LOWER GRANITE RESERVOIR AND LOWER GRANITE DAM

**Annual Report**
**1997 Operations**


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**Funded by**

**U.S. Department of Energy**
**Bonneville Power Administration**
**Division of Fish and Wildlife**
**Pat Poe, Project Manager**
**Contract No. DE-BI79-83BP11631**
**Modification No. A021**
**Project No. 83-323 B**

**IDFG 00-26**

## PREFACE

Project 83-323 addresses measure 5.9A.1 of the 1994 Northwest Power Planning Council Fish and Wildlife Program and the biological need to provide information on the migrating characteristics of the various stocks of salmon and steelhead within the Snake River Basin. This project was initiated in FY 1983 by the National Marine Fisheries Service who built and installed the traps on the Clearwater, Salmon, and Snake rivers. Idaho Department of Fish and Game assumed this work in 1984 and continues to operate traps as part of the annual coordinated Columbia and Snake River Smolt Monitoring Program. This effort provides field monitoring of smolt movement, marked groups of fish for reach survival estimates, as well as other environmental data necessary for water management decisions.

The management implications of this project include: 1) providing information on salmon and steelhead smolt movement at the upper end of the Snake River's series of dam; 2) providing groups of PIT-tagged fish that are used for post-season survival estimates; and 3) application of this information to assist water managers for in-season management decisions relative to flow augmentation, facility power operations, fish collection and transportation programs and operation of the Federal Columbia River Power System (FCRPS) to maximize benefits to smolt survival.

The following report presents results from the 1997 out-migration season and represents the 15$^{th}$ consecutive year of field monitoring in the Snake River system.

Listed below are other reports in this series that are available from Bonneville Power Administration, Division of Fish and Wildlife, P.O. Box 3621, Portland, Oregon 97208-3621.

Buettner, E. W., and A. F. Brimmer. 1997. (In Press) Smolt monitoring at the head of Lower Granite Reservoir and Lower Granite Dam. Idaho Department of Fish and Game, Boise, Idaho. Annual Report 1996 (LIB REF #D239; DOE/BP #11631-13) to Bonneville Power Administration, Project 83-323B, Contract DE-B179-83BP11631.

Buettner, E. W., and A. F. Brimmer. 1996. Smolt monitoring at the head of Lower Granite Reservoir and Lower Granite Dam. Idaho Department of Fish and Game, Boise, Idaho. Annual Report 1995 (LIB REF #D154; DOE/BP #11631-12) to Bonneville Power Administration, Project 83-323B, Contract DE-B179-83BP11631. 89P.

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Buettner, E. W., and V. L. Nelson. 1989. Smolt condition and timing of arrival at Lower Granite Reservoir. Idaho Department of Fish and Game, Boise, Idaho. Annual Report 1988 (LIB REF #D75; DOE/BP #11631-4a) to Bonneville Power Administration, Project 83-323B, Contract DE-B179-83BP11631. 50P.

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Scully, R. J., and E. W. Buettner. 1986. Smolt condition and timing of arrival at Lower Granite Reservoir. Idaho Department of Fish and Game, Boise, Idaho. Annual Report 1985 (LIB REF #D56; DOE/BP #11631-2) to Bonneville Power Administration, Project 83-323B, Contract DE-B179-83BP11631. 78P.

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## ABSTRACT

This project monitored the daily passage of chinook salmon *Oncorhynchus tshawytscha* and steelhead trout *O. mykiss* smolts during the 1997 spring out-migration at migrant traps on the Snake River and Salmon River.

All hatchery chinook salmon released above Lower Granite Dam were marked with a fin clip in 1997. Total annual hatchery chinook salmon catch at the Snake River trap was 49% of the 1996 number but only 6% of the 1995 catch. The wild chinook catch was 77% of the 1996 but was only 13% of 1995. Hatchery steelhead trout catch was 18% of 1996 numbers but only 7% of the 1995 numbers. Wild steelhead trout catch was 22% of 1996 but only 11% of the 1995 numbers. The Snake River trap collected eight age-0 chinook salmon and one sockeye/kokanee salmon *O. nerka*. Differences in trap catch between years are due to fluctuations not only in smolt production, but also differences in trap efficiency and duration of trap operation associated with high flows. Trap operations were terminated for the season due to high flows and trap damage on May 8 and were out of operation for 23 d due to high flow and debris.

Hatchery chinook salmon catch at the Salmon River trap was 37% and wild chinook salmon catch was 60% of 1996 numbers but only 5% and 11% of 1995 catch, respectively. The 1997 hatchery steelhead trout collection was 13% of the 1996 catch and 32% of the 1995 numbers. Wild steelhead trout collection in 1997 was 21% of the 1996 catch and 13% of the 1995 numbers. Trap operations were terminated for the season due to high flows and trap damage on May 7 and were out of operation for 19 d due to high flow and debris.

Travel time (d) and migration rate (km/d) through Lower Granite Reservoir for passive integrated transponder (PIT) tagged steelhead trout marked at the head of the reservoir were affected by discharge. No chinook salmon were PIT tagged at the traps due to their extremely low number. For fish tagged at the Snake River trap, statistical analysis of 1997 detected a significant relation between migration rate and discharge. For hatchery steelhead trout there was a 1.9 fold increase in migration rate between 50 kcfs and 100 kcfs. Insufficient numbers of wild steelhead trout were PIT tagged at the Snake River trap to estimate travel time and migration rate to Lower Granite Dam.

For fish marked at the Salmon River trap, statistical analysis of the 1997 data detected a significant relation between migration rate and discharge for hatchery steelhead trout and found a 4.4-fold increase in migration rate between 50 kcfs and 100 kcfs. Insufficient numbers of wild steelhead trout were PIT tagged at the Salmon River trap to estimate travel time and migration rate to Lower Granite Dam.

Fish tagged with PIT tags at the Snake River trap were interrogated at four dams with PIT tag detection systems (Lower Granite, Little Goose, Lower Monumental, and McNary dams). Because of the addition of the fourth interrogation site (Lower Monumental) in 1993, cumulative interrogation data is not comparable with the prior five years (1988-1992). Cumulative interrogations at the four dams for fish marked at the Snake River trap were 83% for hatchery steelhead and 86% for wild steelhead. Cumulative interrogations at the four dams for fish marked at the Salmon River trap were 77% for hatchery steelhead trout and 83% for wild steelhead trout.



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## INTRODUCTION

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) directed the Northwest Power Planning Council (NWPPC) to develop programs to mitigate for fish and wildlife losses on the Columbia River system resulting from hydroelectric projects. Section 4(h) of the Act explicitly gives the Bonneville Power Administration (BPA) the authority and responsibility to use its resources "to protect, mitigate, and enhance fish and wildlife to the extent affected by the development and operation of any hydroelectric project on the Columbia River system."

Water storage and regulation for hydroelectric generation severely reduces flows necessary for downstream migration of juvenile steelhead trout *Oncorhynchus mykiss* and chinook salmon *O. tshawytscha.* In response to the fishery agencies and Indian tribes recommendations for migration flows, the NWPPC Columbia River Basin Fish and Wildlife Program proposed a "water budget" for augmenting spring flows.

The federal Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.) listing of Snake River spring/summer and fall chinook salmon in 1992 and the development of a National Marine Fisheries Service (NMFS) Biological Opinion (BIOP) established flow measures for the Snake River. The measures within the BIOP establish flow targets and planning dates for providing those flows. The BIOP also requires monitoring and evaluation of the smolt out-migration. The NMFS established a Technical Management Team (TMT) to oversee implementation of the BIOP measures. The TMT utilizes out-migration monitoring data provided by the Idaho Department of Fish and Game (IDFG) through this project as a basis for implementing measures within the flexibility provided by the BIOP.

To provide information to the Fish Passage Center (FPC) for use by the TMT on smolt movement prior to arrival at the lower Snake River reservoirs, IDFG monitors the daily passage of smolts at the head of Lower Granite Reservoir. This information allows the FPC to request operations for fish passage to the TMT for implementation of BIOP measures to improve passage and migration conditions.

Smolt monitoring is a key component of BIOP implementation under all flow conditions and becomes critical when low flow conditions constrain BIOP measures and reduce migration rates. In years of low flow (drought years), knowledge of when most smolts have left tributaries and entered areas that can be affected by releases of stored water allows managers to make informed decisions regarding implementation of measures within the BIOP. Six low-flow years (1987, 1988, 1990, 1991, 1992, 1994) have occurred during this smolt monitoring project. The indications are that judicious use of the available reservoir storage volumes can greatly enhance the timing and migration rate of juvenile chinook salmon and steelhead trout.

The IDFG smolt monitoring project also collects other useful data on relative species composition, hatchery and wild steelhead trout ratios, travel time, and migration rate. All wild steelhead trout smolts are tagged with PIT tags to determine timing of wild adult steelhead trout one and two years later as they return to spawn (Prentice et al. 1987). By monitoring smolt passage at the head of Lower Granite Reservoir and at Lower Granite Dam, migration rates (km/d) under various riverine and reservoir conditions can be estimated and compared. It is possible to determine the relative abundance of hatchery and wild stocks of steelhead trout, which can be used to document wild stock rebuilding progress. This Smolt Monitoring Program's information is complementary to other Snake and Columbia River NWPPC-supported projects.

## OBJECTIVES

1. Provide daily trap catch data at the head of Lower Granite Reservoir for TMT's use in implementing the NMFS BIOP.

2. Determine riverine travel time from the point of release to the smolt traps (index sites) at the upper end of Lower Granite Reservoir for PIT-tagged smolts.

3. Provide an interrogation site for PIT-tagged smolts, marked on other projects, at the end of their migration in a riverine environment and the beginning of their migration in a reservoir environment.

4. Determine reservoir travel time for hatchery spring/summer chinook salmon, wild spring/summer chinook salmon, hatchery steelhead trout, and wild steelhead trout from the head of Lower Granite Reservoir to Lower Granite Dam using PIT-tagged smolts marked at the traps and PIT-tagged smolts passing the traps from upriver hatchery releases and rearing areas.

5. Determine cumulative interrogation rate at Lower Granite, Little Goose, Lower Monumental, and McNary dams during the spring out-migration period for PIT-tagged hatchery and wild spring/summer chinook salmon, hatchery and wild steelhead trout.

6. Correlate smolt migration rate with river flow for fish moving in riverine and reservoir environments.

7. Determine trap efficiency for each species at each trap over a range of discharges.

8. Evaluate timing of returning adult wild and natural steelhead crossing Lower Granite Dam.

## METHODS

### Releases of Hatchery-Produced Smolts

Anadromous hatchery release information was reported for hatchery smolts that contributed to the 1997 out-migration in the Snake River drainage, upstream of Lower Granite Dam. This information included species, number released, date, release location, number PIT tagged, number freeze branded, and associated brand.

### Smolt Monitoring Traps

During the 1997 out-migration, two smolt monitoring traps were operated to monitor the passage of juvenile chinook salmon and steelhead trout. A scoop trap (Raymond and Collins 1974) was located on the Salmon River near Slate Creek, Idaho. A screw trap, formerly operated at the Salmon River trapping site, is no longer in use. A dipper trap (Mason 1966) was located on the Snake River near Lewiston, Idaho (Figure 1). The scoop trap on the Clearwater River was not

operated in 1997 due to budget cuts implemented in 1995. Smolts were captured, examined, and enumerated daily at the traps and released back to the river. Fork length of up to 100 smolts for each species was measured to the nearest millimeter. Up to 60 hatchery steelhead trout and all wild steelhead trout were PIT tagged daily when available. Normally, up to 100 hatchery chinook salmon and 75 wild chinook salmon would also have been PIT tagged at the Salmon and Snake River traps on a daily basis. Due to the low numbers of both hatchery and wild chinook salmon, no chinook were PIT tagged at the traps this year. Up to 2,000 fish were examined for hatchery brands at the Snake River trap. Fish were not examined for brands at the Salmon River trap location. Smolts were anesthetized before handling with tricaine methanesulfonate (MS-222). These fish were allowed to recover from the anesthesia before being returned to the river.

**Snake River Trap**

The Snake River trap was positioned approximately 40 m downstream from the Interstate Bridge, between Lewiston, Idaho and Clarkston, Washington. The trap was attached to bridge piers just east of the drawbridge span by steel cables. This location is at the head of Lower Granite Reservoir, 0.5 km upstream from the convergence of the Snake and Clearwater arms. River width and depth at this location are approximately 260 m and 12 m, respectively.

Steelhead trout smolts were PIT tagged at the Snake River trap to estimate travel time from the head of Lower Granite Reservoir to Lower Granite Dam. Median travel time of the daily PIT-tagged release groups was converted to migration rate. Migration rate was correlated with mean Lower Granite Reservoir inflow discharge for the number of days equal to the median travel time to determine how changes in discharge affected smolt migration rate through Lower Granite Reservoir.

Snake River trap operation began on March 9 and continued through May 8, 1997. The Snake River trap was out of operation for a total of 23 days during the 1997 season due to mechanical failure, heavy debris loads, or because quotas were reached. All fish captured in the Snake River trap were passively interrogated for PIT tags as they entered the live well. The interrogation and tagging information was sent to the PTAGIS Data Center (managed by Pacific States Marine Fisheries Commission) daily.

The PIT tag interrogation system on the Snake River trap consists of an 8-inch PVC pipe with two interrogation coils (D-4 and D-6). Each coil is connected to an exciter card and a PIT tag reader. The system does not have the capability to provide exact time of capture. Since it is checked once daily, the interrogation time is set to 00:00 h. Coil efficiency tests were conducted on the dipper trap interrogation system. Seven hundred forty-two test tags were sent through the system. The reading efficiency was calculated to be 97.6% for both coils combined.

**Clearwater River Trap**

The Clearwater River trap was not operated during the 1997 out-migration due to funding cuts.

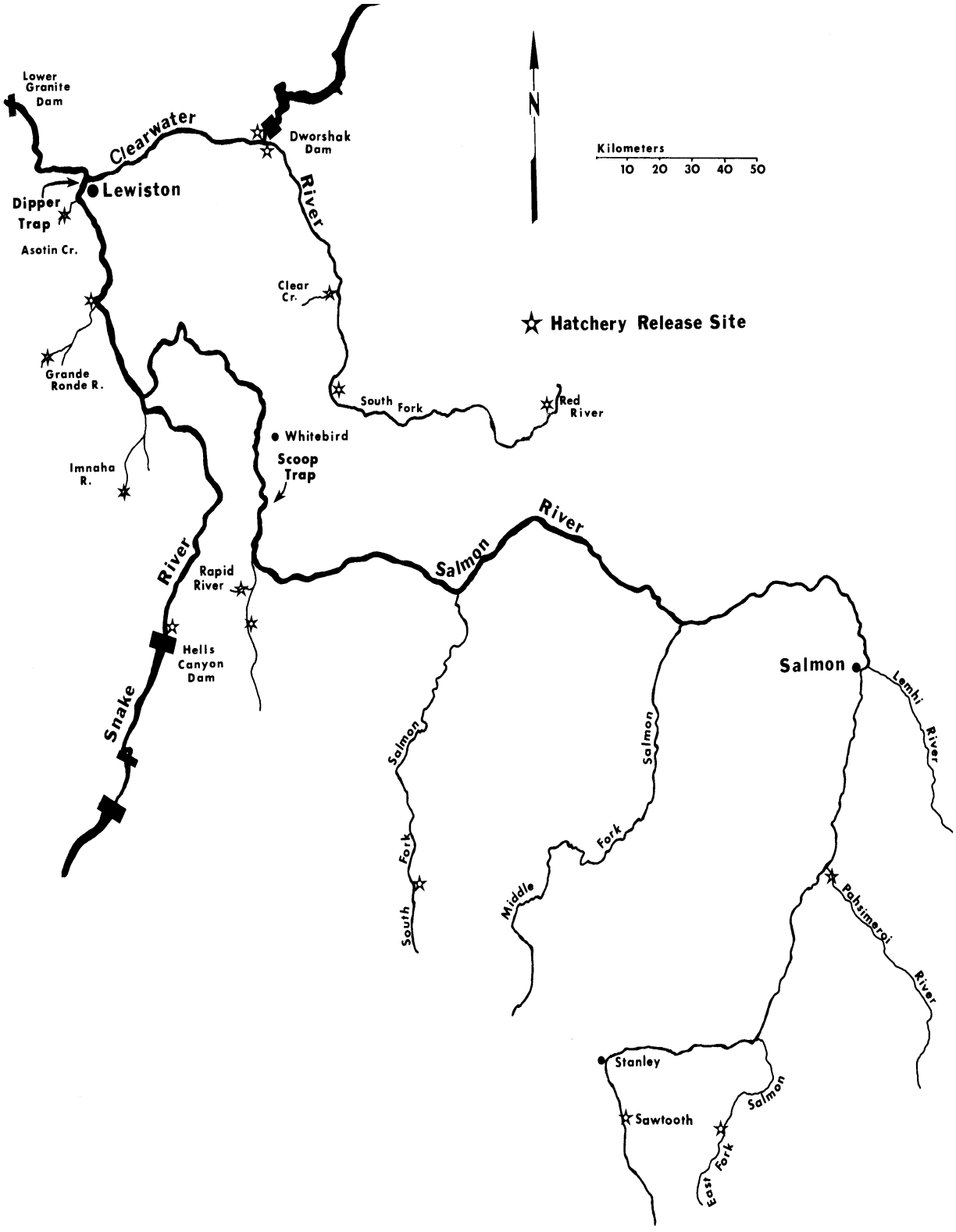



Figure 1. Map of study area.

**Salmon River Trap**

The Salmon River trap site was located at rkm 103, approximately 17 km upstream from the previous trapping location and 1.6 km downstream from Slate Creek. Use of the screw trap has been discontinued at the Salmon River trap site. The scoop trap was operated immediately downstream of the upper U.S. Highway 95 bridge at Twin Bridges. This location was chosen to allow the trap to be operated through a wider range of discharge. River width at this location is approximately 90 m and varies with discharge.

Steelhead trout juveniles were tagged with PIT tags at the Salmon River trap to estimate smolt travel time from the lower portion of the Salmon River to Lower Granite Dam. Median travel time for the daily PIT-tagged release groups was converted to migration rate. Migration rate was correlated with mean Lower Granite Reservoir inflow for the median travel time to determine how changes in discharge affected smolt migration rate through the Lower Salmon River and Lower Granite Reservoir.

Trap operation began on March 10 and continued through May 7 when operations were terminated for the season due to high water. Operations were temporarily suspended for 19 days during the 1997 field season because weekly quotas had been reached or due to mechanical failure. All fish were interrogated for PIT tags as they were removed from the live well. The tagging and interrogation files were sent to the PTAGIS Data Center daily.

The PIT tag interrogation system on the Salmon River trap consists of a 4-inch PVC pipe with two interrogation coils. Each coil is connected to an exciter card (D-8), which is in turn attached to a single PIT tag reader. Coil efficiency tests were conducted on the Salmon River trap interrogation system in 1997. Five hundred test tags were sent through the system. Reading efficiency was calculated to be 100% for both coils combined.

## Trap Efficiency

Trap efficiency is the proportion of the migration run being sampled. Since trap efficiency may change as river discharge changes, efficiency has been estimated several times through the range of discharge at which the trap was operated. A linear regression equation (Ott 1977) describing the relation of trap efficiency and discharge was derived to estimate efficiency at any given discharge. During the 1997 trap operations, trap efficiencies were not calculated for any of the smolt traps. Previous trap efficiency estimates are reported in Buettner (1991).

## Travel Time and Migration Rates

Migration statistics were calculated for hatchery release groups from release sites to traps. Travel time and migration rates to the traps were calculated using median arrival times at the Snake and Salmon River traps. Median arrival (or passage) date is the date the $50^{th}$ percentile fish arrived at the trap or collection facility. Smolts were PIT tagged at the Snake River trap to determine travel time from the head of Lower Granite Reservoir to Lower Granite Dam. Smolts were PIT tagged at the Salmon River trap to determine migration rate in a free-flowing section of river plus Lower Granite Reservoir. Distances from release point to recovery location are listed in Table 1. Individual arrival times at the Lower Granite collection facility were determined for each daily release group. A minimum recapture number, sufficient for use in travel time and migration rate estimations, was derived from an empirical distribution function of the travel time for each individual release group

(Steinhorst et al. 1988). If recapture numbers were less than five or less than the number derived from the empirical distribution function, the daily data were combined with another day's data or the data were not used. If they were combined, they were added to daily data from an adjacent release day that had similar discharge and travel time.

Smolt migration rate/discharge relations through Lower Granite Reservoir were investigated using linear regression analysis after both variables were stratified into 5 kcfs discharge intervals (Mosteller and Tukey 1977) and log (ln) transformed (Zar 1984). The 0.05 level was used to determine significance. This analysis was performed for the PIT-tagged hatchery steelhead trout and wild steelhead trout groups marked at the Snake or Salmon River traps. Normally, hatchery and wild chinook salmon are included in this evaluation, but due to extreme low number of out-migrants expected in 1997, FPC requested that no chinook salmon be PIT tagged to reduce handling.

The migration rate/discharge relations for PIT-tagged hatchery steelhead trout and wild steelhead trout released from the Snake River trap were individually examined from 1988 to 1997 using analysis of covariance to determine if there were groups of years with common slopes and intercepts. Plots were used to help identify years that differ when non-homogeneous slopes between years were found. Subsequent analyses were run, without these years, to determine if common slopes and intercepts existed for a smaller subset of years. Also, the analysis of variance was used to determine if there was a sufficient overlap in the covariate (discharge) between years to continue the analysis (Ostle and Mensing 1975). If the final hypothesis of common intercepts was not rejected, then a significant difference in the migration rate/discharge relations between years was not detected and the yearly data were pooled. After pooling, linear regression was used to find the best-fitting equation to describe the relation between migration rate and discharge for an individual species over several years.

## Interrogation Rates of PIT-Tagged Fish

Interrogation rates of PIT-tagged fish marked at the head of Lower Granite Reservoir to Lower Granite Dam, Little Goose Dam, Lower Monumental, and McNary Dam collection facilities included data from 1988 to 1997 for the Snake River trap, 1989 to 1995 for the Clearwater River trap, and 1993 to 1997 for the Salmon River trap. The data have been examined to ensure that multiple interrogations within a dam and between dams have been removed.

Table 1. River mile and kilometer location for the Snake River drainage.

| | Mouth of Columbia River | | Mouth of Snake River | | Lower Granite Dam | | Snake River Trap Site | | Clearwater River Trap Site | | Salmon River Trap Site | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mi | km | mi | km | mi | km | mi | km | mi | km | mi | km |
| Asotin Creek release site | 470.3 | 756.7 | 146.0 | 234.9 | 38.5 | 61.9 | 6.4 | 10.3 | -- | -- | -- | -- |
| Big Canyon Creek | 585.9 | 942.7 | 261.6 | 420.9 | 154.1 | 247.9 | 122.0 | 196.3 | -- | -- | -- | -- |
| Catherine Creek | 636.9 | 1024.8 | 312.6 | 503.0 | 205.1 | 330.0 | 173.0 | 278.4 | -- | -- | -- | -- |
| Clearwater R. trap site | 470.0 | 756.2 | 145.7 | 234.4 | 38.2 | 61.5 | -- | -- | 0.0 | 0.0 | -- | -- |
| Cottonwood Creek | 521.7 | 839.4 | 197.4 | 317.6 | 89.9 | 144.6 | 57.8 | 93.0 | -- | -- | -- | -- |
| Crooked River | 604.3 | 972.3 | 280.0 | 450.5 | 172.5 | 277.6 | -- | -- | 134.3 | 216.0 | -- | -- |
| Deer Creek | 504.3 | 811.4 | 180.0 | 289.6 | 72.5 | 116.7 | 40.4 | 65.0 | -- | -- | -- | -- |
| Dworshak NFH | 504.3 | 811.4 | 180.0 | 289.6 | 72.5 | 116.6 | -- | -- | 34.3 | 55.2 | -- | -- |
| E.F. Salmon @ trap site | 873.6 | 1405.6 | 549.3 | 883.8 | 441.8 | 710.9 | 409.7 | 659.2 | -- | -- | 297.0 | 478.0 |
| Grande Ronde R. mouth | 493.0 | 793.2 | 168.7 | 271.4 | 61.2 | 98.5 | 29.1 | 46.8 | -- | -- | -- | -- |
| Hazard Creek | 618.7 | 995.5 | 294.4 | 473.7 | 186.9 | 300.7 | 154.8 | 249.1 | -- | -- | 42.1 | 67.9 |
| Hells Canyon Dam | 571.3 | 919.2 | 247.0 | 397.4 | 139.5 | 224.5 | 107.4 | 172.8 | -- | -- | -- | -- |
| Highway 95 boat launch | 473.2 | 761.4 | 148.9 | 239.6 | 41.5 | 66.8 | -- | -- | 3.2 | 5.1 | -- | -- |
| Imnaha Coll. Facility | 565.6 | 910.2 | 241.3 | 388.3 | 133.8 | 215.4 | 101.7 | 163.6 | -- | -- | -- | -- |
| Imnaha River mouth | 516.0 | 830.3 | 191.7 | 309.1 | 84.2 | 135.7 | 52.1 | 83.8 | -- | -- | -- | -- |
| Kooskia NFH | 541.6 | 871.4 | 217.3 | 349.6 | 109.8 | 176.7 | -- | -- | 71.5 | 115.0 | -- | -- |
| Little Sheep Creek | 553.8 | 891.1 | 229.5 | 369.3 | 122.0 | 196.3 | 89.9 | 144.6 | -- | -- | -- | -- |
| Lookingglass Creek | 580.4 | 933.9 | 256.1 | 412.1 | 148.6 | 239.1 | 116.5 | 187.4 | -- | -- | -- | -- |
| Lower Granite Dam | 431.8 | 694.8 | 107.5 | 173.0 | 0.0 | 0.0 | 32.1 | 51.6 | 38.3 | 61.5 | 144.8 | 232.8 |
| Lower Monumental Dam | 365.9 | 588.7 | 41.6 | 66.9 | 65.9 | 106.0 | 98.0 | 157.7 | -- | -- | 192.1 | 308.9 |
| Pahsimeroi Hatchery | 817.5 | 1315.4 | 493.2 | 793.6 | 385.7 | 620.6 | 353.6 | 568.9 | -- | -- | 240.1 | 387.7 |
| Rapid River Hatchery | 605.8 | 974.7 | 281.5 | 452.9 | 174.0 | 280.0 | 141.9 | 228.3 | -- | -- | 29.2 | 47.1 |
| Red River rearing pond | 618.0 | 994.4 | 293.7 | 472.6 | 186.2 | 299.6 | -- | -- | 148.0 | 238.1 | -- | -- |
| Salmon River mouth | 512.5 | 824.6 | 188.2 | 302.8 | 80.7 | 129.8 | 48.6 | 78.2 | -- | -- | 64.1 | 103.0 |
| Salmon River trap site | 576.6 | 927.6 | 252.3 | 405.8 | 144.8 | 232.8 | 112.7 | 181.2 | -- | -- | 0.0 | 0.0 |
| Sawtooth Hatchery | 896.7 | 1444.2 | 573.3 | 922.4 | 465.8 | 749.5 | 433.7 | 697.8 | -- | -- | 321.0 | 516.6 |
| Snake River mouth | 324.3 | 521.8 | 0.0 | 0.0 | 107.5 | 172.9 | 139.6 | 224.6 | 145.7 | 234.5 | 252.3 | 405.8 |
| Snake River trap site | 463.9 | 746.4 | 139.6 | 224.6 | 32.1 | 51.6 | 0.0 | 0.0 | -- | -- | 112.7 | 181.2 |
| S.F. Salmon @ Knox Bridge | 719.7 | 1158.0 | 395.4 | 636.2 | 287.9 | 463.2 | 255.8 | 411.6 | -- | -- | 143.1 | 230.4 |
| Spring Creek | 614.4 | 988.6 | 290.1 | 466.8 | 182.6 | 293.8 | 150.5 | 242.2 | -- | -- | -- | -- |
| Wildcat Creek | 546.2 | 878.8 | 221.9 | 357.0 | 114.4 | 184.3 | 82.3 | 132.4 | -- | -- | -- | -- |

## RESULTS AND DISCUSSION

### Hatchery Releases

#### Chinook Salmon

Chinook salmon released into the Snake River drainage upstream of Lower Granite Dam were reared at nine locations in Idaho, one in Oregon, and one in Washington. A total of 1,424,146 chinook salmon smolts were released at 12 locations in Idaho and two locations in Oregon (Table 2). The number of hatchery chinook salmon released in 1997 was only 14% of the last 10 year average due to the extremely poor adult return in 1995. There were no summer or fall releases of chinook salmon that contributed to the 1997 out-migration.

#### Steelhead Trout

Steelhead trout released into the Snake River drainage upstream of Lower Granite Dam were reared at six locations in Idaho, two in Oregon, and one in Washington. A total of 9,654,611 steelhead trout were released at 21 locations in Idaho, five in Oregon, and two in Washington (Table 3). Fall releases of steelhead trout have not been included in this report.

### Smolt Monitoring Traps

#### Snake River Trap Operation

The Snake River trap captured 1,543 hatchery and 880 wild age-1 chinook salmon, 1,600 hatchery and 196 wild steelhead trout, eight sockeye/kokanee *O. nerka*, and one age-0 wild chinook salmon in 1997 (Table 4).

Hatchery chinook salmon first arrived at the trap on March 21. Catch rates remained below 100 fish per day until April 17. The first and only large peak in hatchery chinook salmon passage began on April 9 and continued through April 29. During this period, 94% of the season total was collected. Catch rates decreased after April 29 and remained below 25 fish per day for the remainder of the season (Figure 2). Trapping operations were terminated on May 8; consequently, any additional peaks in passage that may have occurred after May 8 were not detected. Peak hatchery chinook salmon passage was associated with an increase in Snake River discharge. Less than one percent of the season total was captured in March, 97% in April, and about two percent in May (trap operated for only six days).

Wild chinook salmon were first captured at the Snake River trap on March 19. Numbers remained below 20 fish per day until March 28. There were no large peaks in passage of wild chinook salmon observed at the Snake River trap in 1997. Between March 28 and April 20, daily catch of wild chinook salmon fluctuated but never exceeded 100 fish per day (Figure 2). The low number of wild chinook salmon smolts captured at the Snake River trap in 1997 is due to the poor returns of adult wild chinook salmon in 1995. About 14% of the total catch of wild chinook salmon smolts was captured in March, nearly 85% in April, and 0.9% in May (trap operated for six days in May).

Table 2. Hatchery chinook salmon released into the Snake River system upriver from Lower Granite Dam contributing to the 1997 out-migration.

| Drainage Release Site | Hatchery | Stock | Release Date | No. Released [No. PIT Tagged] |
|---|---|---|---|---|
| **Salmon River** | | | | |
| Pahsimeroi River @ Pahsimeroi Weir | Pahsimeroi | Summer | 4/18/97 | 116,811 [33,017] |
| | Sawtooth | Spring | 4/15/97 | 5,145 |
| Salmon River @ Blaine County Bridge | Sawtooth | Spring | 4/17/97 | 2,274 [729] |
| Salmon River @ Sawtooth Hatchery | Sawtooth | Spring | 4/17/97 | 2,376 [742] |
| South Fork Salmon River @ Knox Bridge | McCall | Summer | 3/19-21/97 | 238,647 [52,688] |
| Rapid River @ Rapid River Hatchery | Rapid River | Spring | 3/17-4/10/97 | 85,840 [40,391] |
| | | | **Drainage Total** | **451,093** |
| **Snake River and Non-Idaho Tributaries** | | | | |
| Snake River @ Pittsburgh Landing | Clearwater | Spring | 4/15/97 | 13,470 [499] |
| | Lyons Ferry | Fall | 4/14-17/97 | 147,316 [9,916] |
| | | | 5/28-7/8/97 | 51,392 [51,392] |
| Imnaha River @ Rkm. 70 | Lookingglass | Spring | 4/6/97 | 52,000 [13,378] |
| Lookingglass Creek @ Rkm. 4.0 | Lookingglass | Spring | 4/8/97 | 156,600 [40,407] |
| | | | **Drainage Total** | **420,779** |
| **Clearwater River** | | | | |
| Upper Selway River @ Beaver Point | Clearwater | Spring | 4/11/97 | 1,426 [1,426] |
| Upper Lochsa River @ Walton Creek | Powell | Spring | 4/15/97 | 3,549 [496] |
| Red River @ Red River Weir | Red River | Spring | 4/14/97 | 2,982 [498] |
| Clear Creek @ Kooskia Hatchery | Kooskia | Spring | 4/8/97 | 16,598 [4,075] |
| North Fork Clearwater River @ Dworshak Hatchery | Dworshak | Spring | 4/7-11/97 | 53,078 [14,080] |
| Clearwater River @ Big Canyon Creek | Lyons Ferry | Fall | 4/14-17/97 | 148,628 [10,051] |
| | | | 5/14-15/97 | 50,771 [2,018] |
| | | | 6/3-7/7/97 | 275,243 [32,451] |
| | | | **Drainage Total** | **552,275** |
| | | | **GRAND TOTAL** | **1,424,146** |

Table 3. Hatchery steelhead trout released into the Snake River system upstream from Lower Granite Dam contributing to the 1997 out-migration.

| Drainage Release Site | Hatchery | Stock | Release Date | No. Released [No. PIT Tagged] |
|---|---|---|---|---|
| **Salmon River** | | | | |
| Salmon River @ Mouth of Lemhi River | Magic Valley | A | 4/16-18/97 | 241,510 [299] |
| Pahsimeroi River @ Pahsimeroi Hatchery | Niagara Springs | A | 4/10-28/97 | 829,851 [800] |
| | Sawtooth | A | 4/5/97 | 5,145 |
| Salmon River @ Mouth of N. F. Salmon R. | Magic Valley | A | 4/21/97 | 134,310 [300] |
| East Fork Salmon River @ East Fork Trap | Magic Valley | B | 4/22-23/97 | 131,220 [300] |
| East Fork Salmon River @ Herd Creek | Magic Valley | B | 4/23-30/97 | 292,954 [300] |
| Upper Salmon River @ Slate Creek | Magic Valley | B | 4/10-5/1/97 | 297,971 [300] |
| Salmon River @ Bruno Bridge | Magic Valley | A | 4/15-16/97 | 150,280 [300] |
| Salmon River @ McNabb Point | Magic Valley | A | 4/14-15/97 | 154,471 [300] |
| | Hagerman | A | 4/24/97 | 75,946 |
| Salmon River @ Torrey's Hole | Sawtooth | A | 4/25/97 | 65,420 [300] |
| Salmon River @ Sawtooth Hatchery | Sawtooth | A | 4/18-5/16/97 | 594,487 [2,595] |
| | Hagerman | A | 4/25/97 | 63,374 |
| Little Salmon River @ Stinky Springs | Magic Valley | B | 4/10/97 | 155,770 [300] |
| | Hagerman | A | 4/14-5/2/97 | 342,281 [300] |
| Little Salmon River @ Warm springs | Niagara Springs | A | 4/29-30/97 | 94,815 [299] |
| Lower Salmon River @ Hammer Creek | Niagara Springs | A | 4/7-9/97 | 137,433 [300] |
| Lower Salmon River @ Pine Bar | Niagara Springs | A | 4/6/97 | 29,700 |
| | | | **Drainage Total** | **3,796,938** |

**Table 3. (Continued.)**

| Drainage Release Site | Hatchery | Stock | Release Date | No. Released [No. PIT Tagged] |
|---|---|---|---|---|
| **Snake River and Non–Idaho Tributaries** | | | | |
| Snake River @ Pittsburgh Landing | Niagara Springs | A | 3/24-4/5/97 | 665,125 [298] |
| Catherine Creek @ R.Km. 27.2 | Irrigon | A | 4/07-11/97 | 62,500 |
| Spring Creek @ R.Km. 0.8 | Wallowa | A | 4/01-16/97 | 523,000 [1,000] |
| | | A | 5/15-30/97 | 162,500 [1,000] |
| Little Sheep Creek @ R.Km. 8 | Irrigon | A | 4/15/97 | 214,000 [500] |
| | | A | 5/13/97 | 116,000 [500] |
| Asotin Creek @ R.Km. 0.8 | Lyons Ferry | A | 4/22-23/97 | 39,997 |
| Deer Creek @ R.Km. 0.5 | Irrigon | A | 4/08-23/97 | 219,000 [2,000] |
| | | A | 5/20-6/4/97 | 211,000 [1,000] |
| Grande Ronde River @ R.Km. 252 | Irrigon | A | 4/07-11/97 | 200,000 |
| Grande Ronde River @ R.Km. 45.4 | Lyons Ferry | A | 4/1-30/97 | 274,886 |
| | | | Drainage Total | **2,688,008** |
| **Clearwater River** | | | | |
| Red River @ Soda Creek Bridge | Clearwater | B | 4/28/97 | 4,991 [985] |
| Crooked River @ R.Km. 9.0 | Clearwater | B | 4/23/97 | 76,008 [2,394] |
| Clearwater River @ Kooskia Bridge | Dworshak | B | 4/21-25/97 | 215,534 [321] |
| South Fork Clearwater River @ Red House Hole | Dworshak | B | 4/21-25/97 | 728,328 |
| | Clearwater | B | 4/28-30/97 | 421,279 [900] |
| Clear Creek @ Kooskia Hatchery | Dworshak | B | 4/21-28/97 | 183,278 [391] |
| | Clearwater | B | 4/28/97 | 179,213 [600] |
| Clearwater River @ Dworshak Hatchery | Dworshak | B | 4/29-5/2/97 | 1,361,034 [4,873] |
| | | **Drainage Total** | | **3,169,665** |
| | | **GRAND TOTAL** | | **9,654,611** |

Table 4. Historical catch of hatchery chinook salmon (HC), wild chinook salmon (WC), hatchery steelhead trout (HS), and wild steelhead trout (WS) collected at the Snake, Clearwater, and Salmon River traps for the out-migration years of 1993 through 1997.

| | | Snake R. Trap | Clearwater R. Trap | Salmon R. Trap |
|---|---|---|---|---|
| 1997 | HC | 1,543 | No Data | 2,280 |
| | WC | 898 | | 1,065 |
| | HS | 1,600 | | 1, 267 |
| | WS | 196 | | 66 |
| 1996 | HC | 3,163 | No Data | 6,205 |
| | WC | 1,140 | | 1,776 |
| | HS | 8,921 | | 9,566 |
| | WS | 896 | | 304 |
| 1995 | HC | 26,919 | 13,475 | 45,349 |
| | WC | 6,564 | 1,534 | 9,396 |
| | HS | 23,994 | 8,314 | 3,948 |
| | WS | 1,750 | 285 | 499 |
| 1994 | HC | 22,789 | 32,789 | 38,902 |
| | WC | 1,471 | 1,343 | 4,774 |
| | HC | 31,662 | 4,615 | 7,383 |
| | WS | 3,439 | 1,798 | 564 |
| 1993 | HC | 15,271 | 9,761 | 28,326 |
| | WC | 2,683 | 320 | 5,147 |
| | HS | 35,183 | 10,122 | 7,315 |
| | WS | 3,046 | 882 | 948 |

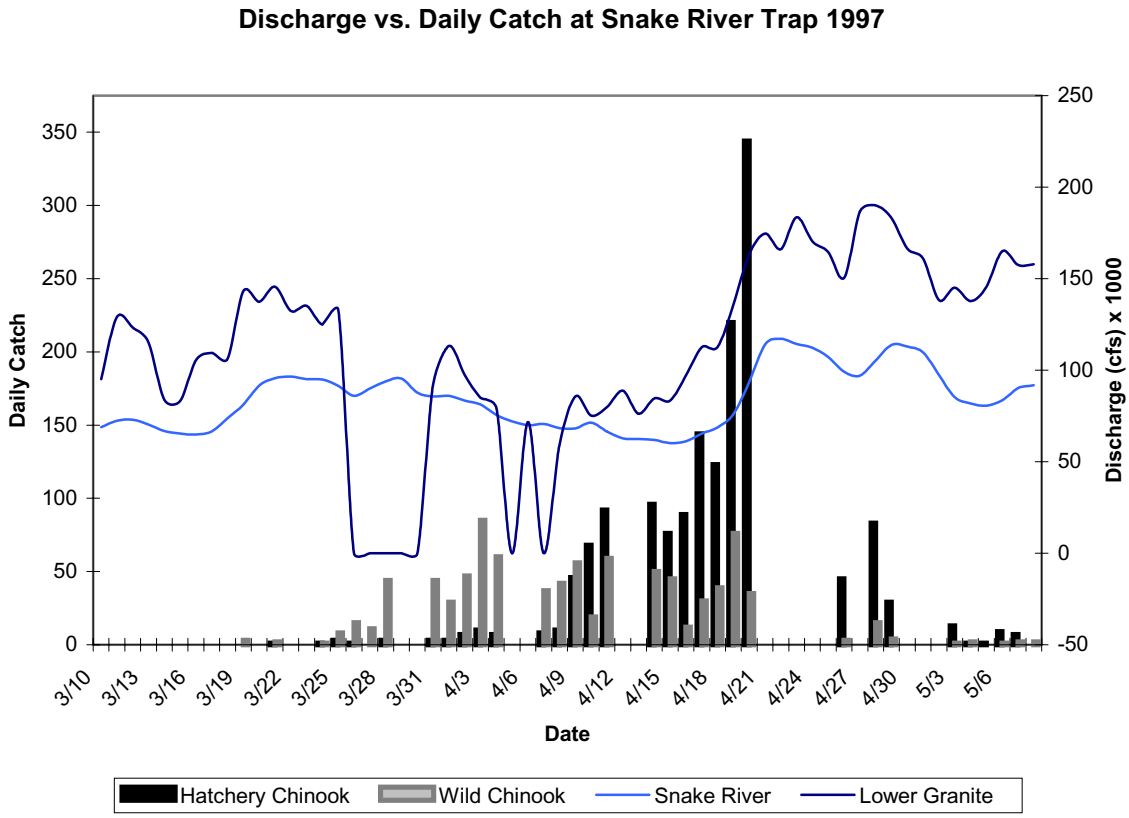



Figure 2. Snake River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Snake River and Lower Granite discharge, 1997.

Hatchery steelhead trout were first observed at the trap on March 19. Catch rates remained below seven fish per day for the remainder of the month. Daily catch steadily increased during April with the season high occurring on April 20. Following April 20, daily catch decreased throughout the remainder of the month. Daily catch of hatchery steelhead trout increased again during the first week of May (Figure 3). Trapping operations were terminated on May 8; consequently, any additional peaks in passage that may have occurred after May 8 were not detected. Analysis of catch by month revealed that less than one percent of the season total was collected in March, nearly 77% in April, and about 23% in May (trap operated for six days in May).

Wild steelhead trout passage timing was similar to hatchery steelhead trout passage (Figure 3). Nearly five percent of the total catch of wild steelhead trout was collected in March, 79% in April, and 16% in May (trap operated for six days in May).

Snake River discharge, measured at the Anatone gauge, ranged from 64.8 kcfs to 96.5 kcfs in March. The average discharge in March of 78.3 kcfs was 7.2 kcfs greater than in 1996, 41.9 kcfs greater than in 1995, and 54.7 kcfs greater than in 1994. The average April discharge was 83.9 kcfs, with a peak of 117.1 kcfs on April 22. April average discharge was 1.3, 42.2, 52.0 kcfs greater than in 1996, 1995, and 1994, respectively. The average May discharge of 106.5 kcfs was 23.8, 28.4, and 61.5 kcfs greater than in 1996, 1995, and 1994, respectively.

Water temperature at the Snake River trap was 6°C at the beginning of the trapping season. Water temperature gradually increased throughout the sampling season and reached a maximum of 16°C on May 6 (Figure 4).

Secchi disk transparency measurements were taken daily at the Snake River trap. Transparencies fluctuated throughout the trapping season and ranged from 0.2 m to 0.7 m (Figure 4).

**Salmon River Trap Operation**

The Salmon River scoop trap captured 2,280 age-1 hatchery chinook salmon, 1,065 age-1 wild chinook salmon, 1,267 hatchery steelhead trout, 66 wild steelhead trout, and one sockeye/kokanee salmon *O. nerka* in 1997 (Table 4).

Large numbers (>100 per day) of hatchery chinook salmon were collected daily during the latter part of March (Figure 5). Hatchery chinook salmon collected during this time probably originated from Rapid River Hatchery. Collections remained high (>100 per day) until March 28 when the catch rate dropped to less than 50 hatchery chinook salmon per day. A second peak in passage was observed from April 9 through April 19. Any additional peaks in passage that may have occurred after April 19 were not detected due to poor trap location (trap not in thalweg). Daily trap catch of hatchery chinook salmon remained low (<20 per day) for the remainder of the trapping season (Figure 5). About 55% of the total catch of hatchery chinook salmon was captured in March, 43% was collected in April, and about 2% in May (trap operated for six days in May).

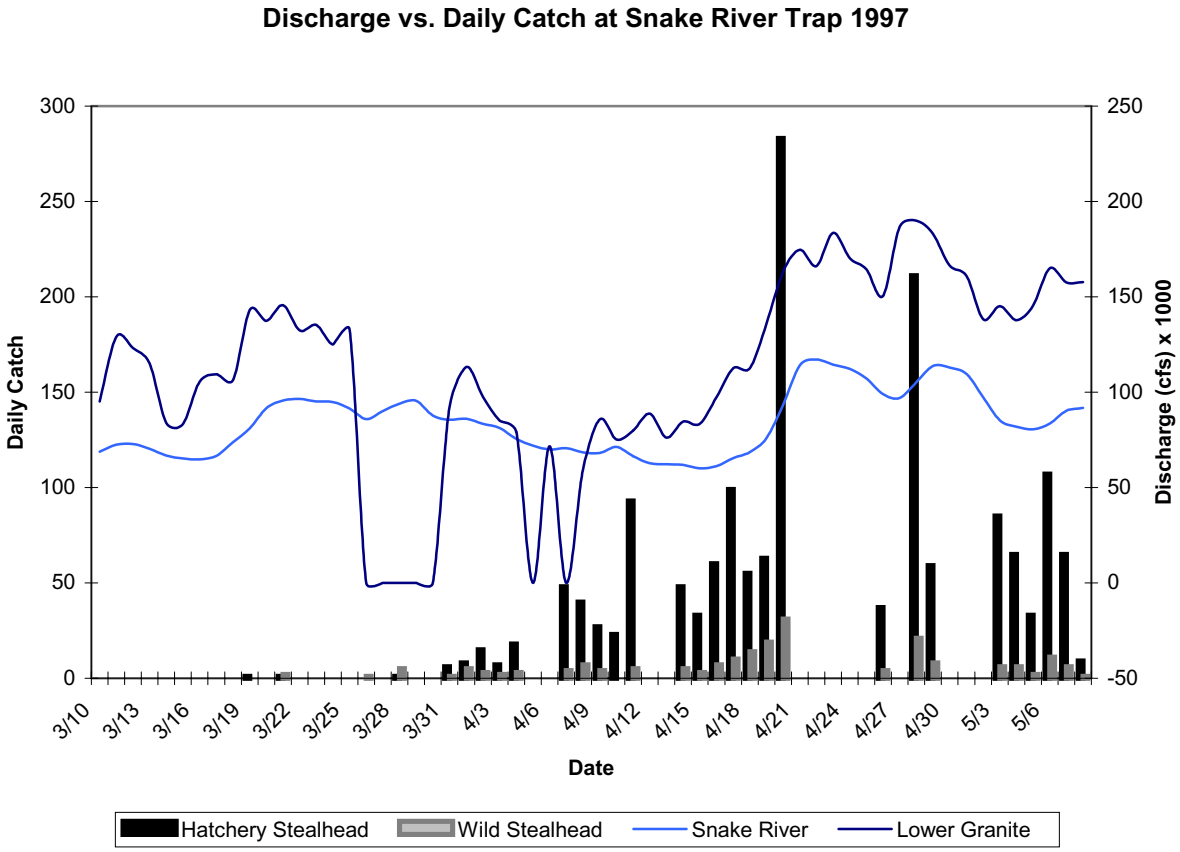



Figure 3. Snake River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Snake River and Lower Granite discharge, 1997.

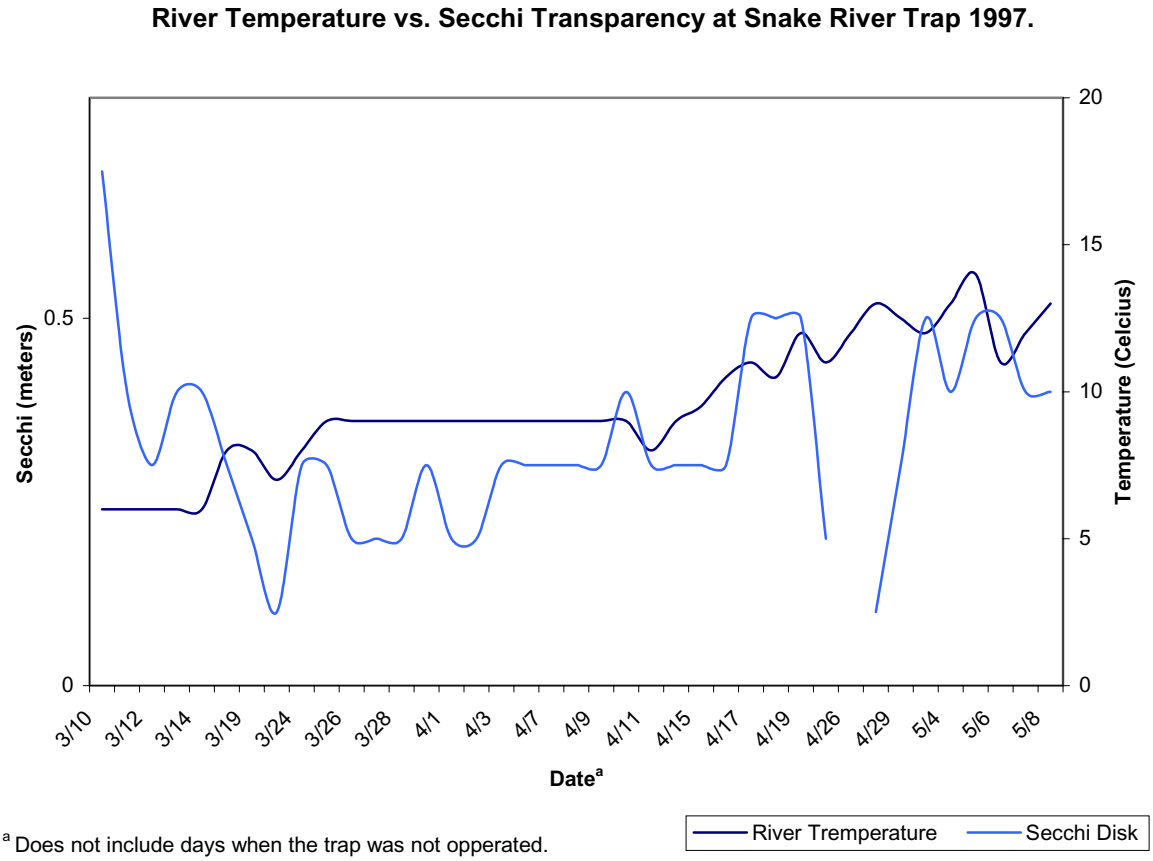



Figure 4. Daily water temperature and Secchi dish transparency for the Snake River at the trap, 1997.

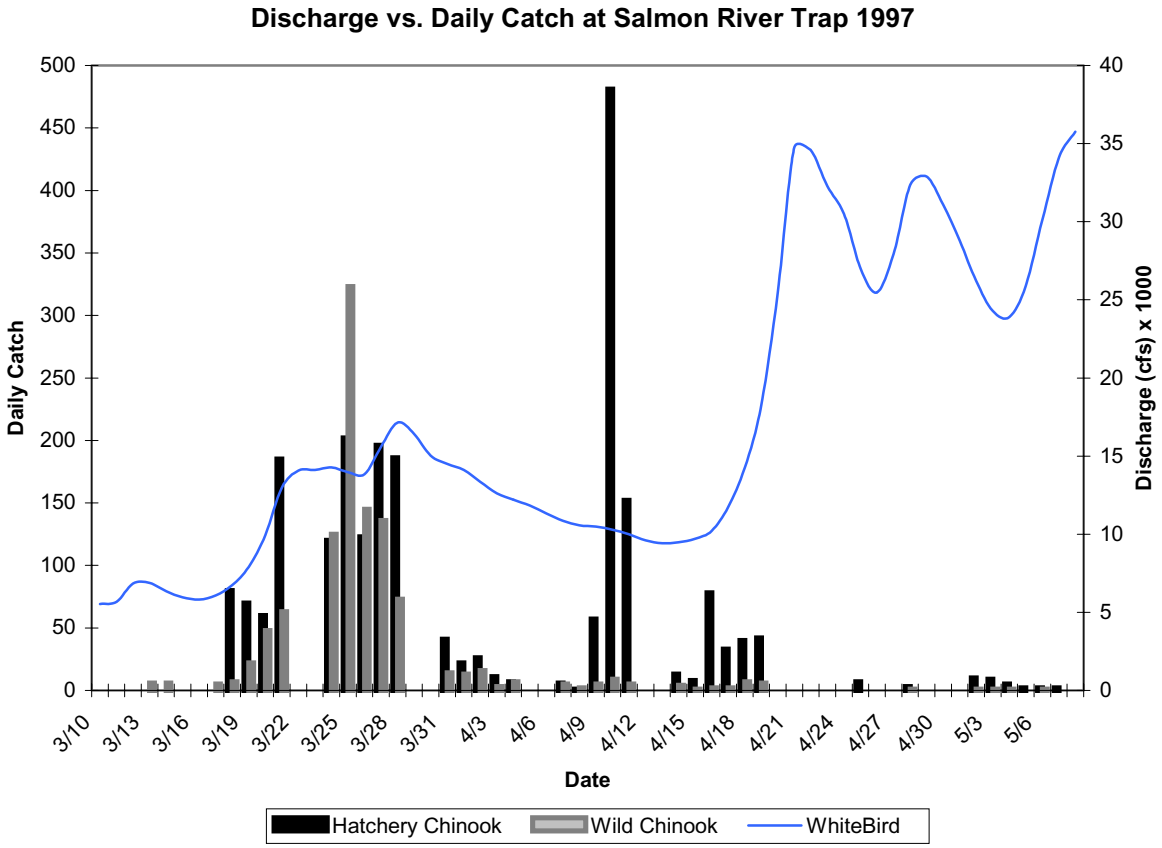



Figure 5. Salmon River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Salmon River discharge, 1997.

Wild chinook salmon began arriving at the Salmon River trap in relatively high numbers (>50 per day) in mid-March. There was only one peak in wild chinook passage observed in 1997 (Figure 5). The peak began on March 19, reached its maximum on March 25, and ended on April 2. For the remainder of the season, wild chinook salmon were collected at a rate of less than 15 fish per day. Any additional peaks in passage that may have occurred during late April and May were not detected due to high discharge and poor trap location. Approximately 91% of the total catch of wild chinook salmon was collected in March, 8% was captured in April, and nearly 1% in May (trap operated for six days in May).

One major peak in hatchery steelhead trout passage was observed at the Salmon River trap in 1997. Hatchery steelhead trout first arrived at the trap on April 10. Trap catch increased rapidly from April 10 through April 14 and remained high (>60 per day) through May 8 when operations were terminated for the season due to high discharge and debris (Figure 6). Any additional peaks in passage that may have occurred after May 8 were not detected. There were no hatchery steelhead trout collected during March, but 49% of the season total was collected in April and 51% in May.

Wild steelhead trout began to arrive in low numbers (<10 per day) during the last two weeks of March. During this period, 20% of the season total was collected. From March 29 through April 17, only five wild steelhead trout were collected at the trap. The first and only large peak in wild steelhead trout passage began on April 18 and was still in progress when operations were terminated for the season on May 7. During this period, 72% of the season total was collected. Twenty percent of the season total was captured in March, 40% was collected in April, and 40% in May.

Salmon River discharge in March, measured at the White Bird gauge, ranged from 5.4 kcfs to 17.1 kcfs and averaged 9.2 kcfs. Average March discharge in 1997 was nearly identical to that observed in 1996 (9.1 kcfs), but 1.6 kcfs greater than in 1995, and 4.8 kcfs greater than in 1994. Discharge increased in April and ranged from 9.4 kcfs to 34.8 kcfs. The April average discharge of 18.5 kcfs was 0.3 kcfs less than in 1996 but 8.7 and 7.8 kcfs greater than in 1995 and 1994, respectively. May average discharge was 59.0 kcfs and ranged from 23.9 kcfs to 99.0 kcfs. May average discharge for 1996, 1995, and 1994 was 41.5, 32.3, and 20.3 kcfs, respectively.

Water temperatures at the Salmon River trap ranged from 3.0°C to 8.5°C and fluctuated throughout the field season (Figure 7). Secchi disk transparency fluctuated throughout the trapping season and ranged from 0.3 m to 2.2 m (Figure 7).

## Travel Time and Migration Rates

### Release Sites to Snake River Trap

**Hatchery Chinook Salmon**—In 1997, 313 hatchery chinook salmon were interrogated at the Snake River trap. Twenty-four chinook salmon released from the Imnaha River Weir were captured at the Snake River trap. Migration time ranged from 2 to 25 d with the mean travel time being 11 d. Four chinook salmon released from the Imnaha River trap were captured at the Snake River trap. Travel time ranged from 2 d to 8 d. One hundred and thirty-nine hatchery chinook released from Lookingglass Hatchery were captured at the Snake River trap. Travel time ranged from less than 1 d to 28 d and averaged 7 d. Twenty-two hatchery chinook marked in Lookingglass Creek during the summer and fall of 1996 were captured at the Snake River trap. Thirty-eight spring chinook salmon released from Rapid River Hatchery were captured at the trap. Travel time cannot

be calculated, because the release from Rapid River Hatchery is volitional and spans several weeks, which does not allow for a specific release date. Seventy-one McCall hatchery summer chinook salmon released on the South Fork of the Salmon River at the Knox Bridge were captured at the Snake River trap. Travel time varied from 12 to 46 d and averaged 29 d. Four chinook salmon released from the Pahsimeroi pond were captured at the Snake River trap. Travel time varied from 7 d to 12 d. One chinook salmon released from the Sawtooth trap was captured at the Snake River trap. Ten-hatchery fall chinook salmon released on the Snake River at Pittsburgh Landing were captured at the Snake River trap. Travel time averaged less than 1 d.

**Wild Chinook Salmon**—In 1997, 12 wild chinook salmon were interrogated at the Snake River trap. Wild chinook numbers interrogated at the Snake River trap were lower in 1997 due to the fact that wild chinook were not marked at any of the Smolt Monitoring sites. Three of the fish were tagged in the Imnaha River in the fall of 1996, two were tagged at the Imnaha trap, three were tagged in the Lostine River in the fall of 1996, and one was tagged on the Minam River. One was tagged at the Lemhi weir, one on the Secesh River, and one at the South Fork Salmon River trap.

**Hatchery Steelhead Trout**—In 1997, five PIT-tagged hatchery steelhead trout were interrogated at the Snake River trap. One released from the Pahsimeroi pond, one released in the Salmon River, one released from the Salmon River trap, one released from the Snake River trap, and one released from the Wallowa Hatchery.

**Wild Steelhead Trout**—In 1997, there were two PIT-tagged wild steelhead trout interrogated at the Snake River trap. One was released from the Salmon River trap and the other was released from the Snake River trap.

**Sockeye Salmon**—In 1997, there were no hatchery sockeye salmon interrogated at the Snake River trap.

### Release Sites to the Salmon River Trap

**Hatchery Chinook Salmon**—In 1997, 386 PIT-tagged hatchery chinook salmon were interrogated at the Salmon River trap. A group released from the South Fork Salmon River had 128 recaptures at the Salmon River trap. Travel time ranged from 5 d to 30 d and averaged 8 d. A group that was released from Rapid River hatchery had 249 recaptures at the Salmon River trap. Travel time could not be calculated because this group was volitionally released and a release date could not be calculated. The last group was released from the Pahsimeroi Pond, and nine chinook salmon were recaptured at the Salmon River trap. Travel time ranged from 5 d to 25 d and averaged 11 d.

**Wild Chinook Salmon**—In 1997, four PIT-tagged wild chinook salmon were interrogated at the Salmon River trap. One was released from Lake Creek and the other three were released from the South Fork Salmon River trap.

**Hatchery Steelhead Trout**—In 1997, no PIT-tagged hatchery steelhead trout were interrogated at the Salmon River trap.

**Wild Steelhead Trout**—In 1997, no PIT-tagged wild steelhead trout were interrogated at the Salmon River trap.

**Sockeye Salmon**—In 1997, no PIT-tagged wild or hatchery sockeye salmon were interrogated at the Salmon River trap.

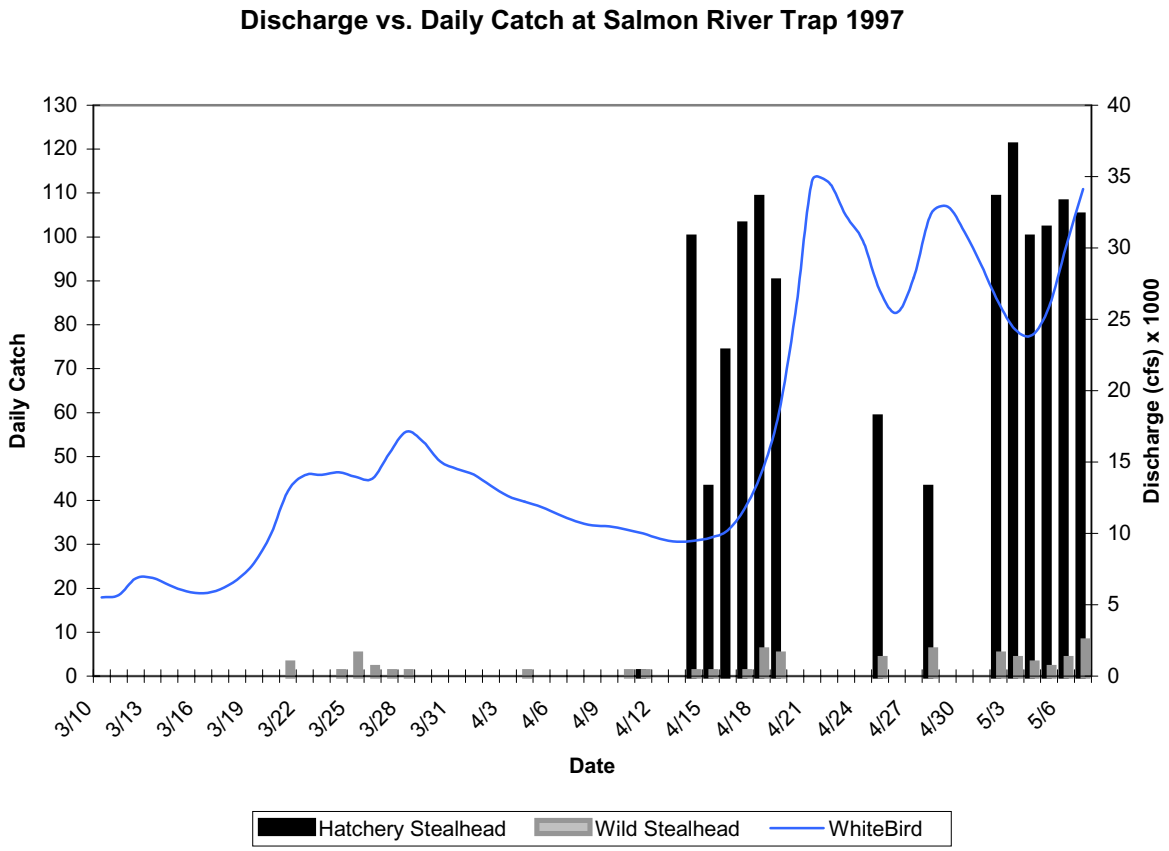
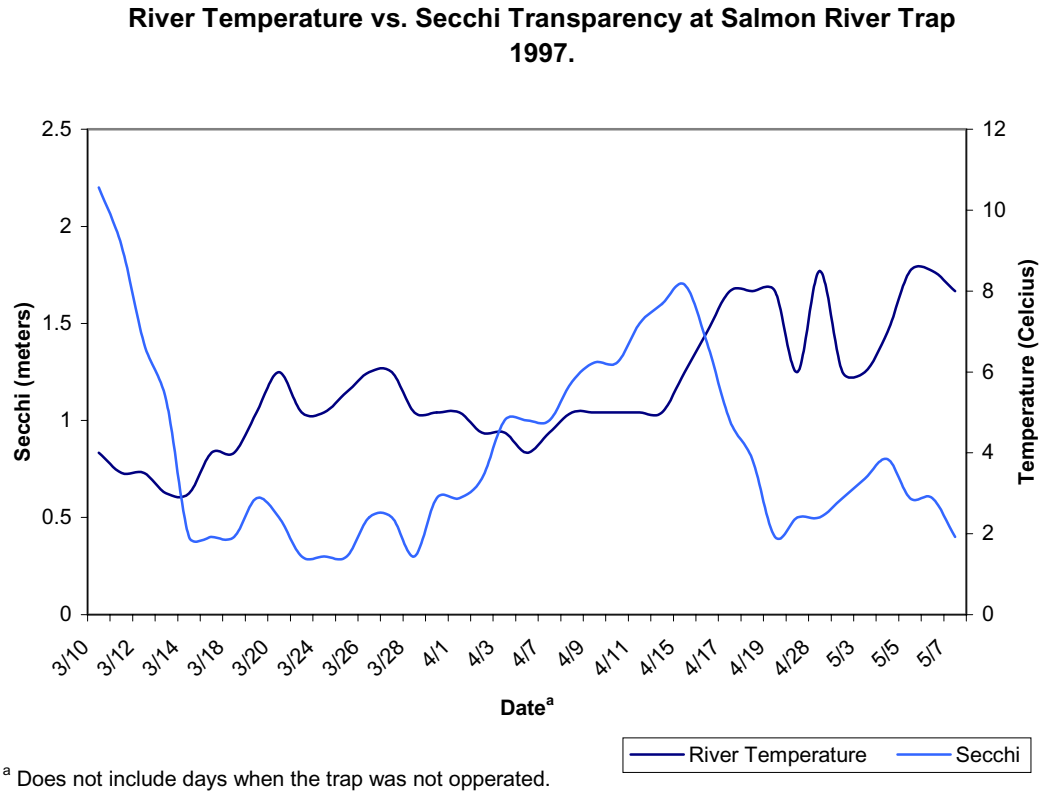



Figure 6. Salmon River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Salmon River discharge, 1997.




[a] Does not include days when the trap was not opperated.

Figure 7. Daily temperature and Secchi dish transparency for the Salmon River.

**Head of Lower Granite Reservoir to Lower Granite Dam**

The PIT tag sample rate at the dams changed significantly during the 1997 out-migration mainly due to the fluctuation of spill. This is the fifth year since the Smolt Monitoring Project began PIT tagging in 1987 that a significant period of spill occurred. The following example illustrates how median travel time estimates are affected by spill.

> A group of fish tagged and released at the Snake River trap passes Lower Granite Dam over a ten-day period. When spill occurs, the facility sampling efficiency for these fish is decreased because a portion of the fish that would normally be sampled instead pass via spill. Spill during the second half of the passage period could cause the number of fish during that half to be underestimated, making the date the median fish passed Lower Granite earlier than the actual date. Likewise, spill during the first half of the passage period would artificially shift the date of median passage later than the true date. The calculation of mean discharge for the median migration period is affected by the incorrect estimate of the median migration period. If discharge were increasing for the passage period of the above group and spill occurred during the second half, thereby making the date of median passage earlier, then mean discharge for that group is also underestimated.

Another effect spill may have on migration rate is that the more highly smolted fish are more buoyant and migrate higher in the water column. They are also the fastest migrating fish (Beeman and Rondorf, in press). The ten-foot-deep debris boom in front of the turbines at Lower Granite Dam may divert a greater portion of these higher floating fish to the spill where they are not interrogated. A greater portion of the deeper migrating, slower moving fish may migrate through the powerhouse and be collected and subsequently interrogated (Giorgi et al. 1988). This type of bias would incorrectly estimate migration rate with the estimated median migration rate being less than the true rate. This makes any interpretation of the PIT tag data at the dams extremely difficult during the periods of major operational changes. It also means that if fish collected at Lower Granite Dam are transported, then the portion of the population that passes Lower Granite is no longer representative of the population that arrived at Lower Granite.

**Hatchery Chinook Salmon PIT Tag Groups**—In 1997, hatchery chinook salmon smolts were not PIT-tagged at either the Snake or Salmon River traps, as requested by FPC, due to extreme low numbers of smolts expected to out-migrate.

**Wild Chinook Salmon PIT Tag Groups**—In 1997, wild chinook salmon smolts were not PIT-tagged at either the Snake or Salmon River traps, as requested by FPC, due to extreme low numbers of smolts expected to out-migrate.

**Hatchery Steelhead Trout PIT Tag Groups**—Sufficient numbers of hatchery steelhead trout were PIT-tagged daily at the Snake River trap to provide 18 daily release groups (1,459 individual fish) for median migration rate calculations through Lower Granite Reservoir from April 7 through May 7 (Appendix A, Table 1). Median travel time ranged from 2.92 to 1.1 d (17.6 km/d to 46.9 km/d migration rate) and averaged 2.0 d (25.7 km/d).

Linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite inflow (Table 5) for PIT-tagged hatchery steelhead trout groups (Table 6). The equation shows that as discharge increases, migration rate increases.

Table 5. Migration rates (km/day), stratified by 5 kcfs intervals from the Snake River trap to Lower Granite Dam, 1997.

| Discharge Interval | Hatchery Steelhead | Wild Steelhead |
|---|---|---|
| 70 - 75 | 22.10 | - |
| 75 - 80 | - | 16.70 |
| 80 - 85 | 18.57 | 21.50 |
| 85 - 90 | 19.70 | 15.30 |
| 90 - 95 | - | 19.90 |
| 95 - 100 | 22.30 | - |
| 100 - 105 | - | - |
| 105 - 110 | 24.60 | 15.60 |
| 110 - 115 | - | - |
| 115 - 120 | - | 26.90 |
| 120 - 125 | 24.60 | - |
| 125 - 130 | - | - |
| 130 - 135 | - | 26.30 |
| 135 - 140 | 25.70 | 31.10 |
| 140 - 145 | 37.40 | 36.90 |
| 145 - 150 | 34.90 | 10.60 |
| 150 - 155 | - | 10.90 |
| 155 - 160 | 37.80 | - |
| 160 - 165 | 37.50 | 45.70 |
| 165 - 170 | 42.60 | - |
| 170 - 175 | - | - |
| 175 - 180 | 46.50 | - |
| 180 - 185 | - | 49.60 |
| 185 - 190 | 43.70 | - |

Table 6. Linear regression statistics for migration rate/discharge relation by species, rearing type, and trap, using data stratified by 5 kcfs intervals, 1997.

| Species | Trap | N | Intercept | Slope | $r^2$ | P |
|---|---|---|---|---|---|---|
| Hatchery Steelhead | Snake River | 14 | -1.075 | 0.924 | 0.837 | <0.001 |
| | Salmon River | 8 | -6.727 | 2.154 | 0.838 | 0.001 |
| Wild Steelhead | Snake River | 9 | -1.616 | 1.059 | 0.824 | 0.001 |
| | Salmon River | 5 | -0.482 | 0.971 | 0.701 | 0.077 |

The ten years of migration rate discharge data (1988-1997) were combined and the linear regression analysis conducted to provide an average regression equation. A strong relation was found between migration rate and discharge ($r^2$ = 0.866, N = 115, P <0.001). The best linear regression equation was:

ln (migration rate) = -3.451 + 1.392 ln (mean discharge).

The analysis indicated there were two outliers which when remove changes $r^2$ to 0.891. The best linear regression equation was:

ln (migration rate) = -3.607 + 1.428 ln (mean discharge).

Fourteen groups of hatchery steelhead trout (1,252 fish) were PIT tagged at the Salmon River trap in 1997 for use in median migration rate calculations to Lower Granite Reservoir (Appendix A, Table 2). Median travel time ranged from 6.9 to 3.4 d (31.3 km/d to 63.8 km/d) and averaged 4.1 d (56.8 km/d).

Data stratified by 5 kcfs groups were used in the regression analysis (Table 7). The linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite discharge for PIT-tagged hatchery steelhead trout groups marked at the Salmon River trap (Table 6). The equation shows that as discharge increases, migration rate increases.

**Wild Steelhead Trout PIT Tag Groups**—Insufficient numbers of wild steelhead trout (148 fish) were PIT tagged at the Snake River trap to estimate travel time and migration rate to Lower Granite Dam (Appendix A, Table 3).

Insufficient numbers of wild steelhead trout (59 fish) were PIT tagged at the Salmon River trap in 1997 to determine migration rate to Lower Granite Dam (Appendix A, Table 4).

## Interrogation of PIT-Tagged Fish

Interrogation data in 1997 are not directly comparable with the earlier years. All species-run-rearing types will be underestimated due to a reduction in collection efficiency during spill at the dams. During other times of the season, the interrogation rate may vary sporadically due to fluctuations in turbine operations. The fourth collection facility in the system, at Lower Monumental Dam, became operational in 1993 and therefore total interrogations may be greater beginning in 1993 than in previous years. Therefore, any comparison in trends of cumulative detections at dams must be done cautiously, in a manner that incorporates these additional factors.

Interrogation rate of Snake River trap daily release groups for PIT-tagged hatchery chinook salmon and wild chinook salmon cannot be calculated because chinook salmon were not PIT tagged at either the Snake or Salmon River traps.

Percent interrogation of Snake River trap hatchery steelhead trout and wild steelhead trout daily PIT tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 32.7% to 72.3% for hatchery fish (Appendix B, Table 1). Wild steelhead trout ranged from 33.3% to 100%, (Appendix B, Table 2). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 69.6% and 90.4%, and averaged 83.1% (Table 8). Wild steelhead

trout cumulative interrogation rates ranged between 71.4% and 100%, and averaged 85.8% (Table 8).

Percent interrogation of Salmon River trap hatchery steelhead trout daily PIT tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 38.1% to 57.5% (Appendix B, Table 3). Not enough wild steelhead trout were PIT tagged to calculate daily interrogation rate (Appendix B, Table 4). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 57.1% to 84.5%, and averaged 76.7% (Table 8). Wild steelhead trout averaged 83.1% (Table 8).

Table 7. Migration rates (km/day), stratified by 5 kcfs intervals from the Snake River trap to Lower Granite Dam, 1997.

| Discharge Interval | Hatchery Steelhead | Wild Steelhead |
|---|---|---|
| 70 - 75 | - | - |
| 75 - 80 | - | - |
| 80 - 85 | - | - |
| 85 - 90 | - | - |
| 90 - 95 | - | - |
| 95 - 100 | - | - |
| 100 - 105 | - | - |
| 105 - 110 | - | 32.15 |
| 110 - 115 | - | 9.10 |
| 115 - 120 | - | - |
| 120 - 125 | 33.90 | 38.20 |
| 125 - 130 | 39.30 | - |
| 130 - 135 | 49.50 | 73.20 |
| 135 - 140 | - | 39.50 |
| 140 - 145 | 64.40 | - |
| 145 - 150 | 62.35 | 53.28 |
| 150 - 155 | 64.25 | 79.70 |
| 155 - 160 | 73.25 | 98.93 |
| 160 - 165 | - | 57.00 |
| 165 - 170 | - | - |
| 170 - 175 | - | 72.90 |
| 175 - 180 | 74.50 | 85.10 |
| 180 - 185 | - | - |
| 185 - 190 | - | - |

Table 8. Interrogations of PIT-tagged fish from the Snake River trap, 1987-1997; Clearwater River trap, 1989-1995; and Salmon River trap, 1993-1997, at downstream collection facilities.

| | | | | Number Interrogated/Site | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Year | Species[a] | Number Tagged | Ints at Lower Granite | % GRJ[b] | Ints at Little Goose | % GOJ[c] | Ints at Lower Monumental | % LMJ[d] | Ints at McNary | % MCJ[e] | Grand Total Ints | Total % Observed |
| **Snake** | 1997 | CH | - | - | - | - | - | - | - | - | - | - | - |
| | 1996 | CH | 1,450 | 497 | 34.3% | 259 | 17.9% | 189 | 13.0% | 40 | 2.8% | 985 | 67.9% |
| | 1995 | CH | 3,927 | 1,646 | 41.9% | 643 | 16.4% | 430 | 11.0% | 153 | 3.9% | 2,872 | 73.1% |
| | 1994 | CH | 2,844 | 885 | 31.1% | 332 | 11.7% | 223 | 7.8% | 329 | 11.6% | 1,769 | 62.2% |
| | 1993 | CH | 3,203 | 1,336 | 41.7% | 494 | 15.4% | 246 | 7.7% | 134 | 4.2% | 2,210 | 69.0% |
| | 1992 | CH | 410 | 166 | 40.5% | 83 | 20.2% | - | 0.0% | 48 | 11.7% | 297 | 72.4% |
| **Snake** | 1997 | CW | - | - | - | - | - | - | - | - | - | - | - |
| | 1996 | CW | 842 | 269 | 31.9% | 190 | 22.6% | 119 | 14.1% | 40 | 4.8% | 618 | 73.4% |
| | 1995 | CW | 2,067 | 1,023 | 49.5% | 366 | 17.7% | 216 | 10.5% | 68 | 3.3% | 1,673 | 80.9% |
| | 1994 | CW | 934 | 354 | 37.9% | 95 | 10.2% | 82 | 8.8% | 83 | 8.9% | 614 | 65.7% |
| | 1993 | CW | 1,125 | 576 | 51.2% | 150 | 13.3% | 57 | 5.1% | 46 | 4.1% | 829 | 73.7% |
| **Snake** | 1992 | CU | 615 | 249 | 40.5% | 106 | 17.2% | - | 0.0% | 72 | 11.7% | 427 | 69.4% |
| | 1991 | CU | 2,131 | 929 | 43.6% | 409 | 19.2% | - | 0.0% | 115 | 5.4% | 1,453 | 68.2% |
| | 1990 | CU | 2,245 | 956 | 42.6% | 310 | 13.8% | - | 0.0% | 180 | 8.0% | 1,446 | 64.4% |
| | 1989 | CU | 6,222 | 2,384 | 38.3% | 1,367 | 22.0% | - | 0.0% | 482 | 7.7% | 4,233 | 68.0% |
| | 1988 | CU | 3,767 | 1,237 | 32.8% | 543 | 14.4% | - | 0.0% | 299 | 7.9% | 2,079 | 55.2% |
| | 1987[f] | CU | 3,275 | 1,067 | 32.6% | 338 | 10.3% | - | 0.0% | 308 | 9.4% | 1,713 | 52.3% |
| **Snake** | 1997 | SH | 1,459 | 750 | 51.4% | 328 | 22.5% | 123 | 8.4% | 12 | 0.8% | 1,213 | 83.1% |
| | 1996 | SH | 1,363 | 675 | 49.5% | 247 | 18.1% | 139 | 10.2% | 24 | 1.8% | 1,085 | 79.6% |
| | 1995 | SH | 2,244 | 1,477 | 65.8% | 236 | 10.5% | 165 | 7.4% | 19 | 0.8% | 1,897 | 84.5% |
| | 1994 | SH | 3,239 | 1,298 | 40.1% | 216 | 6.7% | 112 | 3.5% | 40 | 1.2% | 1,666 | 51.4% |
| | 1993 | SH | 2,521 | 1,925 | 76.4% | 235 | 9.3% | 63 | 2.5% | 13 | 0.5% | 2,236 | 88.7% |
| | 1992 | SH | 3,904 | 1,496 | 38.3% | 227 | 5.8% | - | 0.0% | 30 | 0.8% | 1,753 | 44.9% |
| | 1991 | SH | 2,577 | 2,032 | 78.9% | 268 | 10.4% | - | 0.0% | 11 | 0.4% | 2,311 | 89.7% |
| | 1990 | SH | 3,112 | 2,272 | 73.0% | 282 | 9.1% | - | 0.0% | 33 | 1.1% | 2,587 | 83.1% |
| | 1989 | SH | 2,525 | 1,773 | 70.2% | 268 | 10.6% | - | 0.0% | 35 | 1.4% | 2,076 | 82.2% |
| | 1988 | SH | 1,743 | 1,069 | 61.3% | 190 | 10.9% | - | 0.0% | 12 | 0.7% | 1,271 | 72.9% |
| | 1987 | SH | 827 | 324 | 39.2% | 52 | 6.3% | - | 0.0% | 6 | 0.7% | 382 | 46.2% |

Table 8. (Continued.)

| Site | Year | Species[a] | Number Tagged | Number Interrogated/Site: Ints at Lower Granite | % GRJ[b] | Ints at Little Goose | % GOJ[c] | Ints at Lower Monumental | % LMJ[d] | Ints at McNary | % MCJ[e] | Grand Total Ints | Total % Observed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Snake** | 1997 | SW | 148 | 82 | 55.4% | 38 | 25.7% | 6 | 4.1% | 1 | 0.7% | 127 | 85.8% |
| | 1996 | SW | 655 | 293 | 44.7% | 137 | 20.9% | 67 | 10.2% | 12 | 1.8% | 509 | 77.7% |
| | 1995 | SW | 1,537 | 967 | 62.9% | 195 | 12.7% | 122 | 7.9% | 13 | 0.8% | 1,297 | 84.4% |
| | 1994 | SW | 2,840 | 1,546 | 54.4% | 319 | 11.2% | 158 | 5.6% | 51 | 1.8% | 2,074 | 73.0% |
| | 1993 | SW | 2,867 | 1,982 | 69.1% | 267 | 9.3% | 133 | 4.6% | 32 | 1.1% | 2,414 | 84.2% |
| | 1992 | SW | 2,538 | 1,511 | 59.5% | 307 | 12.1% | - | 0.0% | 31 | 1.2% | 1,849 | 72.9% |
| | 1991 | SW | 3,549 | 2,266 | 63.8% | 625 | 17.6% | - | 0.0% | 66 | 1.9% | 2,957 | 83.3% |
| | 1990 | SW | 3,078 | 2,016 | 65.5% | 356 | 11.6% | - | 0.0% | 60 | 1.9% | 2,432 | 79.0% |
| | 1989 | SW | 1,798 | 1,170 | 65.1% | 240 | 13.3% | - | 0.0% | 52 | 2.9% | 1,462 | 81.3% |
| | 1988 | SW | 1,186 | 698 | 58.9% | 166 | 14.0% | - | 0.0% | 20 | 1.7% | 884 | 74.5% |
| | 1987 | SW | 464 | 229 | 49.4% | 48 | 10.3% | - | 0.0% | 8 | 1.7% | 285 | 61.4% |
| **Clearwater** | 1995 | CH | 2,467 | 950 | 38.5% | 414 | 16.8% | 269 | 10.9% | 109 | 4.4% | 1,742 | 70.6% |
| | 1994 | CH | 1,998 | 500 | 25.0% | 192 | 9.6% | 188 | 9.4% | 247 | 12.4% | 1,127 | 56.4% |
| | 1993 | CH | 1,624 | 553 | 34.1% | 193 | 11.9% | 106 | 6.5% | 77 | 4.7% | 929 | 57.2% |
| | 1992 | CH | 5,200 | 1,654 | 31.8% | 745 | 14.3% | - | 0.0% | 429 | 8.3% | 2,828 | 54.4% |
| **Clearwater** | 1995 | CW | 1,051 | 464 | 44.1% | 173 | 16.5% | 88 | 8.4% | 37 | 3.5% | 762 | 72.5% |
| | 1994 | CW | 761 | 308 | 40.5% | 94 | 12.4% | 81 | 10.6% | 41 | 5.4% | 524 | 68.9% |
| | 1993 | CW | 298 | 134 | 45.0% | 43 | 14.4% | 25 | 8.4% | 18 | 6.0% | 220 | 73.8% |
| **Clearwater** | 1992 | CU | 1,461 | 502 | 34.4% | 202 | 13.8% | - | 0.0% | 136 | 9.3% | 840 | 57.5% |
| | 1991 | CU | 3,943 | 1,483 | 37.6% | 668 | 16.9% | - | 0.0% | 235 | 6.0% | 2,386 | 60.5% |
| | 1990 | CU | 4,242 | 1,359 | 32.0% | 674 | 15.9% | - | 0.0% | 281 | 6.6% | 2,314 | 54.6% |
| | 1989 | CU | 2,441 | 756 | 31.0% | 452 | 18.5% | - | 0.0% | 140 | 5.7% | 1,348 | 55.2% |
| **Clearwater** | 1995 | SH | 867 | 602 | 69.4% | 69 | 8.0% | 56 | 6.5% | 3 | 0.3% | 730 | 84.2% |
| | 1994 | SH | 1,250 | 729 | 58.3% | 119 | 9.5% | 30 | 2.4% | 10 | 0.8% | 888 | 71.0% |
| | 1993 | SH | 1,102 | 813 | 73.8% | 79 | 7.2% | 24 | 2.2% | 6 | 0.5% | 922 | 83.7% |
| | 1992 | SH | 1,567 | 823 | 52.5% | 118 | 7.5% | - | 0.0% | 6 | 0.4% | 947 | 60.4% |
| | 1991 | SH | 1,215 | 926 | 76.2% | 89 | 7.3% | - | 0.0% | 3 | 0.2% | 1,018 | 83.8% |
| | 1990 | SH | 1,228 | 880 | 71.7% | 63 | 5.1% | - | 0.0% | 10 | 0.8% | 953 | 77.6% |
| | 1989 | SH | 290 | 173 | 59.7% | 16 | 5.5% | - | 0.0% | 2 | 0.7% | 191 | 65.9% |

Table 8. (Continued.)

| Site | Year | Species[a] | Number Tagged | Number Interrogated/Site: Ints at Lower Granite | % GRJ[b] | Ints at Little Goose | % GOJ[c] | Ints at Lower Monumental | % LMJ[d] | Ints at McNary | % MCJ[e] | Grand Total Ints | Total % Observed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Clearwater** | 1995 | SW | 268 | 157 | 58.6% | 40 | 14.9% | 16 | 6.0% | 1 | 0.4% | 214 | 79.9% |
| | 1994 | SW | 1,297 | 421 | 32.5% | 150 | 11.6% | 106 | 8.2% | 24 | 1.9% | 701 | 54.0% |
| | 1993 | SW | 849 | 560 | 66.0% | 106 | 12.5% | 58 | 6.8% | 9 | 1.1% | 733 | 86.3% |
| | 1992 | SW | 2,996 | 1,599 | 53.4% | 477 | 15.9% | - | 0.0% | 113 | 3.8% | 2,189 | 73.1% |
| | 1991 | SW | 1,300 | 767 | 59.0% | 126 | 9.7% | - | 0.0% | 22 | 1.7% | 915 | 70.4% |
| | 1990 | SW | 727 | 409 | 56.3% | 102 | 14.0% | - | 0.0% | 28 | 3.9% | 539 | 74.1% |
| | 1989 | SW | 104 | 53 | 51.0% | 16 | 15.4% | - | 0.0% | 3 | 2.9% | 72 | 69.2% |
| **Salmon** | 1997 | CH | - | - | - | - | - | - | - | - | - | - | - |
| | 1996 | CH | 2,554 | 618 | 24.2% | 343 | 13.4% | 258 | 10.1% | 67 | 2.6% | 1,286 | 50.4% |
| | 1995 | CH | 5,074 | 1,777 | 35.0% | 757 | 14.9% | 531 | 10.5% | 186 | 3.7% | 3,251 | 64.1% |
| | 1994 | CH | 3,633 | 870 | 23.9% | 322 | 8.9% | 258 | 7.1% | 358 | 9.9% | 1,808 | 49.8% |
| | 1993 | CH | 3,138 | 1,144 | 36.5% | 385 | 12.3% | 233 | 7.4% | 157 | 5.0% | 1,919 | 61.2% |
| **Salmon** | 1997 | CW | - | - | - | - | - | - | - | - | - | - | - |
| | 1996 | CW | 1,425 | 381 | 26.7% | 289 | 20.3% | 181 | 12.7% | 31 | 2.2% | 882 | 61.9% |
| | 1995 | CW | 3,937 | 1,790 | 45.5% | 689 | 17.5% | 366 | 9.3% | 122 | 3.1% | 2,967 | 75.4% |
| | 1994 | CW | 2,913 | 1,113 | 38.2% | 287 | 9.9% | 188 | 6.5% | 202 | 6.9% | 1,790 | 61.4% |
| | 1993 | CW | 2,169 | 1,112 | 51.3% | 286 | 13.2% | 125 | 5.8% | 91 | 4.2% | 1,614 | 74.4% |
| **Salmon** | 1997 | SH | 1,252 | 627 | 50.1% | 213 | 17.0% | 118 | 9.4% | 1 | 0.1% | 960 | 76.6% |
| | 1996 | SH | 1,410 | 598 | 42.4% | 205 | 14.5% | 140 | 9.9% | 24 | 1.7% | 967 | 68.6% |
| | 1995 | SH | 1,556 | 937 | 60.2% | 190 | 12.2% | 118 | 7.6% | 14 | 0.9% | 1,259 | 80.9% |
| | 1994 | SH | 2,596 | 1,001 | 38.6% | 164 | 6.3% | 70 | 2.7% | 36 | 1.4% | 1,271 | 49.0% |
| | 1993 | SH | 1,641 | 1,203 | 73.3% | 112 | 6.8% | 44 | 2.7% | 13 | 0.8% | 1,372 | 83.6% |
| **Salmon** | 1997 | SW | 59 | 38 | 64.4% | 6 | 10.2% | 5 | 8.5% | 0 | 0.0% | 49 | 83.1% |
| | 1996 | SW | 251 | 112 | 44.6% | 49 | 19.5% | 21 | 8.4% | 1 | 0.4% | 183 | 72.9% |
| | 1995 | SW | 435 | 251 | 57.7% | 59 | 13.6% | 32 | 7.4% | 1 | 0.2% | 343 | 78.9% |
| | 1994 | SW | 532 | 260 | 48.9% | 44 | 8.3% | 32 | 6.0% | 10 | 1.9% | 346 | 65.0% |
| | 1993 | SW | 902 | 575 | 63.7% | 73 | 8.1% | 36 | 4.0% | 5 | 0.6% | 689 | 76.4% |

[a] CH=hatchery chinook, CW=wild chinook, CU=unknown chinook, SH=hatchery steelhead, SW=wild steelhead.
[b] GRJ = Lower Grainte Juvenile
[c] GOJ = Little Goose Juvenile
[d] LMJ = Lower Monumental Juvenile
[e] MCJ = McNary Juvenile
[f] Bias may exist as only "quality" fish were tagged.

## SUMMARY

Hatchery chinook salmon releases above Lower Granite Dam for 1997 were 65.9% of 1996 numbers but only 12.2% of 1995's total. Hatchery steelhead trout releases were 94.8% of 1996 numbers and 101.7% of 1995 numbers. Hatchery production of chinook salmon in the Clearwater River drainage was 74.8%, the Snake River and non-Idaho tributaries 97.0%, and the Salmon River drainage 45.6% of 1996 production. Hatchery production of steelhead trout in the Clearwater River drainage was 97%, the Snake River and non-Idaho tributaries was 96.1%, and the Salmon River was 87.7% of last year's total. Hatchery production of chinook salmon and steelhead trout released above Lower Granite Dam was 1,424,147 and 9,654,611 respectively, in 1997.

The Snake River trap was operated on the east side of the river from March through May 8 and was out of operation for 23 days during this period due to high flow, mechanical failures, and because quotas were reached. The Snake River trap captured 1,543 age-1 hatchery chinook salmon, 880 wild chinook salmon, one age-0 chinook salmon, 1,600 hatchery steelhead trout, 196 wild steelhead trout, and eight sockeye/kokanee.

The Salmon River trap was operated on the east side of the river from March 10 through May 7 and was out of operation for 19 days during this period due to high flow, mechanical failures, and because quotas were reached. The Salmon River trap captured 2,280 age-1 hatchery chinook salmon, 1,065 wild chinook salmon, 1,267 hatchery steelhead trout, 66 wild steelhead trout, and one sockeye/kokanee.

A significant migration rate/discharge relation was detected for hatchery steelhead trout released from both traps to Lower Granite Dam. Insufficient numbers of wild steelhead trout were PIT tagged at either the Snake or Salmon River traps to estimate travel time and migration rate to Lower Granite Dam. No chinook salmon were PIT tagged at either trap to determine migration rate discharge relations due to extremely low number of both hatchery and wild chinook.

In all instances where the migration rate/discharge relation was significant, the same trend was seen: as discharge increased migration rate increased. A 40 kcfs (60-100 kcfs) increase in discharge would generally produce a two-fold increase in migration rate for hatchery chinook salmon released from the Snake River trap during the low flow years 1988, 1990-1992, and 1994 and about a five-fold increase for near normal flow years 1989, 1993, and 1995. Hatchery and wild steelhead trout released from the Snake River trap both showed about a two- to three-fold increase in migration rate with a two-fold increase in discharge.

The four-dam interrogation rates for 1997 were only comparable to 1993-1996 because of the addition of a new collection facility at Lower Monumental Dam in 1993. The comparability between the four years is questionable because the collection efficiency changed during the out-migration due to operational changes and spill at the dams.

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**APPENDICES**

Appendix A. Table 1. PIT-tagged hatchery steelhead trout travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1997.

| Release Date | Median Travel Time | Lower Confidence Interval[a] | Upper Confidence Interval[a] | Number Observed at Granite | Number Tagged at Trap | Percent Recaptured | Migration Rate (km/day) | Average Discharge |
|---|---|---|---|---|---|---|---|---|
| 4/7/97 | 2.91 | 2.50 | 3.69 | 34 | 48 | 70.83% | 17.7 | 88.00 |
| 4/8/97 | 2.34 | 2.08 | 4.33 | 23 | 38 | 60.53% | 22.1 | 73.33 |
| 4/9/97 | 2.83 | 2.16 | 3.80 | 13 | 27 | 48.15% | 18.2 | 82.50 |
| 4/10/97 | 2.92 | 2.05 | 3.32 | 12 | 23 | 52.17% | 17.6 | 80.00 |
| 4/11/97 | 2.59 | 2.85 | 2.31 | 49 | 92 | 53.26% | 19.9 | 82.50 |
| 4/14/97 | 2.38 | 2.08 | 2.85 | 20 | 40 | 50.00% | 21.7 | 88.33 |
| 4/15/97 | 2.31 | 2.04 | 3.97 | 17 | 32 | 53.13% | 22.3 | 97.67 |
| 4/16/97 | 2.10 | 1.95 | 4.12 | 27 | 59 | 45.76% | 24.6 | 107.67 |
| 4/17/97 | 2.09 | 1.85 | 3.19 | 32 | 98 | 32.65% | 24.6 | 120.67 |
| 4/18/97 | 2.00 | 1.72 | 2.42 | 20 | 55 | 36.36% | 25.7 | 137.33 |
| 4/19/97 | 1.25 | 1.19 | 1.45 | 32 | 62 | 51.61% | 41.4 | 149.50 |
| 4/20/97 | 1.21 | 1.29 | 1.17 | 154 | 282 | 54.61% | 42.6 | 169.00 |
| 4/28/97 | 1.18 | 1.27 | 1.11 | 105 | 210 | 50.00% | 43.7 | 186.50 |
| 4/29/97 | 1.11 | 1.01 | 1.23 | 25 | 59 | 42.37% | 46.5 | 175.00 |
| 5/3/97 | 1.38 | 1.76 | 1.27 | 60 | 83 | 72.29% | 37.4 | 141.50 |
| 5/4/97 | 1.82 | 1.60 | 2.13 | 32 | 64 | 50.00% | 28.4 | 149.33 |
| 5/5/97 | 1.28 | 1.21 | 1.51 | 21 | 33 | 63.64% | 40.3 | 155.00 |
| 5/6/97 | 1.38 | 1.27 | 1.53 | 40 | 95 | 42.11% | 37.5 | 161.50 |
| 5/7/97 | 1.46 | 1.28 | 1.79 | 34 | 59 | 57.63% | 35.3 | 158.00 |

[a] Confidence intervals calculated with nonparametric statistics.

Appendix A. Table 2. PIT-tagged wild steelhead trout travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1997.

| Release Date | Median Travel Time | Lower Confidence Interval[a] | Upper Confidence Interval[a] | Number Observe at Granite | Number Tagged at Trap | Percent Recaptured | Migration Rate (km/day) | Average Discharge |
|---|---|---|---|---|---|---|---|---|
| 4/7/97 | 3.38 | 0.00 | 0.00 | 2 | 4 | 50.00% | 15.3 | 88.00 |
| 4/8/97 | 3.09 | 2.25 | 3.53 | 6 | 6 | 100.00% | 16.7 | 75.00 |
| 4/9/97 | 2.18 | 0.00 | 0.00 | 1 | 4 | 25.00% | 23.7 | 80.33 |
| 4/11/97 | 2.67 | 0.00 | 0.00 | 2 | 5 | 40.00% | 19.3 | 82.50 |
| 4/14/97 | 3.77 | 0.00 | 0.00 | 3 | 5 | 60.00% | 13.7 | 98.20 |
| 4/15/97 | 1.98 | 0.00 | 0.00 | 2 | 3 | 66.67% | 26.1 | 97.67 |
| 4/16/97 | 3.30 | 0.00 | 0.00 | 2 | 7 | 28.57% | 15.6 | 114.75 |
| 4/17/97 | 1.92 | 0.00 | 0.00 | 2 | 8 | 25.00% | 26.9 | 120.67 |
| 4/18/97 | 1.96 | 1.49 | 4.05 | 7 | 14 | 50.00% | 26.3 | 137.33 |
| 4/19/97 | 1.40 | 1.23 | 2.24 | 13 | 19 | 68.42% | 36.9 | 149.50 |
| 4/20/97 | 1.13 | 1.02 | 1.28 | 20 | 30 | 66.67% | 45.7 | 169.00 |
| 4/28/97 | 1.04 | 0.88 | 1.22 | 7 | 21 | 33.33% | 49.6 | 186.50 |
| 4/29/97 | 3.89 | 0.00 | 0.00 | 2 | 8 | 25.00% | 13.3 | 158.80 |
| 5/3/97 | 1.66 | 1.19 | 13.42 | 6 | 6 | 100.00% | 31.1 | 142.67 |
| 5/4/97 | 4.88 | 0.00 | 0.00 | 5 | 6 | 83.33% | 10.6 | 152.17 |
| 5/5/97 | 6.08 | 0.00 | 0.00 | 2 | 2 | 100.00% | 8.5 | 159.57 |

[a] Confidence intervals calculated with nonparametric statistics.

Appendix A. Table 3. PIT-tagged hatchery steelhead trout travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1997.

| Release Date | Median Travel Time | Lower Confidence Interval[a] | Upper Confidence Interval[a] | Number Observe at Granite | Number Tagged at Trap | Percent Recaptured | Migration Rate (km/day) | Average Discharge |
|---|---|---|---|---|---|---|---|---|
| 4/14/97 | 6.89 | 8.06 | 6.33 | 47 | 98 | 47.96% | 33.9 | 120.62 |
| 4/15/97 | 5.94 | 5.05 | 7.16 | 20 | 41 | 48.78% | 39.3 | 125.71 |
| 4/16/97 | 4.71 | 5.32 | 4.19 | 42 | 73 | 57.53% | 49.5 | 132.83 |
| 4/17/97 | 3.63 | 3.90 | 3.30 | 57 | 103 | 55.34% | 64.4 | 140.00 |
| 4/18/97 | 2.87 | 3.33 | 2.71 | 59 | 109 | 54.13% | 81.4 | 146.75 |
| 4/19/97 | 2.33 | 2.64 | 2.12 | 47 | 90 | 52.22% | 100.0 | 158.00 |
| 4/25/97 | 4.01 | 2.97 | 5.40 | 27 | 59 | 45.76% | 58.3 | 175.20 |
| 4/28/97 | 2.58 | 1.96 | 8.36 | 16 | 42 | 38.10% | 90.7 | 175.25 |
| 5/2/97 | 5.40 | 6.36 | 4.24 | 58 | 108 | 53.70% | 43.3 | 148.17 |
| 5/3/97 | 4.58 | 5.49 | 3.61 | 56 | 121 | 46.28% | 51.1 | 151.50 |
| 5/4/97 | 3.02 | 3.82 | 2.90 | 47 | 98 | 47.96% | 77.4 | 151.50 |
| 5/5/97 | 3.73 | 4.10 | 3.13 | 54 | 101 | 53.47% | 62.6 | 155.00 |
| 5/6/97 | 3.81 | 4.70 | 3.08 | 45 | 105 | 42.86% | 61.3 | 158.80 |
| 5/7/97 | 3.38 | 4.60 | 2.62 | 52 | 104 | 50.00% | 69.1 | 157.25 |

[a] Confidence intervals calculated with nonparametric statistics.

Appendix A. Table 4. PIT-tagged wild steelhead trout travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1997.

| Release Date | Median Travel Time | Lower Confidence Interval[a] | Upper Confidence Interval[a] | Number Observe at Granite | Number Tagged at Trap | Percent Recaptured | Migration Rate (km/day) | Average Discharge |
|---|---|---|---|---|---|---|---|---|
| 3/25/97 | 19.10 | 0.00 | 0.00 | 2 | 4 | 50.00% | 12.2 | 108.65 |
| 3/26/97 | 5.92 | 0.00 | 0.00 | 2 | 2 | 100.00% | 39.5 | 138.71 |
| 3/27/97 | 25.78 | 0.00 | 0.00 | 1 | 1 | 100.00% | 9.1 | 112.41 |
| 3/28/97 | 6.11 | 0.00 | 0.00 | 1 | 1 | 100.00% | 38.2 | 123.29 |
| 4/14/97 | 23.64 | 0.00 | 0.00 | 1 | 1 | 100.00% | 9.9 | 149.44 |
| 4/15/97 | 4.48 | 0.00 | 0.00 | 1 | 1 | 100.00% | 52.1 | 108.40 |
| 4/17/97 | 3.19 | 0.00 | 0.00 | 1 | 1 | 100.00% | 73.2 | 131.25 |
| 4/18/97 | 2.67 | 0.00 | 0.00 | 5 | 6 | 83.33% | 87.5 | 146.75 |
| 4/19/97 | 4.10 | 0.00 | 0.00 | 3 | 5 | 60.00% | 57.0 | 164.80 |
| 4/25/97 | 3.21 | 0.00 | 0.00 | 2 | 4 | 50.00% | 72.9 | 173.25 |
| 4/28/97 | 2.75 | 0.00 | 0.00 | 4 | 6 | 66.67% | 85.1 | 175.25 |
| 5/2/97 | 5.18 | 0.00 | 0.00 | 3 | 5 | 60.00% | 45.1 | 148.17 |
| 5/3/97 | 3.31 | 0.00 | 0.00 | 3 | 4 | 75.00% | 70.6 | 148.25 |
| 5/4/97 | 2.93 | 0.00 | 0.00 | 1 | 3 | 33.33% | 79.7 | 151.50 |
| 5/5/97 | 1.94 | 0.00 | 0.00 | 1 | 2 | 50.00% | 120.0 | 156.00 |
| 5/6/97 | 2.88 | 0.00 | 0.00 | 2 | 4 | 50.00% | 81.1 | 157.50 |
| 5/7/97 | 2.44 | 0.00 | 0.00 | 5 | 8 | 62.50% | 95.7 | 155.00 |

[a] Confidence intervals calculated with nonparametric statistics.

Appendix B. Table 1. PIT-tagged hatchery steelhead trout interrogated at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Snake River trap.

| Date | Tagged | Granite | % | Little Goose | % | Low Mon. | % | McNary | % | Total % |
|---|---|---|---|---|---|---|---|---|---|---|
| 4/7/97 | 48 | 34 | 70.83% | 3 | 6.25% | 0 | 0.00% | 0 | 0.00% | 77.08% |
| 4/8/97 | 38 | 23 | 60.53% | 5 | 13.16% | 2 | 5.26% | 1 | 2.63% | 81.58% |
| 4/9/97 | 27 | 13 | 48.15% | 5 | 18.52% | 3 | 11.11% | 0 | 0.00% | 77.78% |
| 4/10/97 | 23 | 12 | 52.17% | 1 | 4.35% | 1 | 4.35% | 2 | 8.70% | 69.57% |
| 4/11/97 | 92 | 49 | 53.26% | 11 | 11.96% | 10 | 10.87% | 0 | 0.00% | 76.09% |
| 4/14/97 | 40 | 20 | 50.00% | 12 | 30.00% | 3 | 7.50% | 0 | 0.00% | 87.50% |
| 4/15/97 | 32 | 17 | 53.13% | 5 | 15.63% | 3 | 9.38% | 0 | 0.00% | 78.13% |
| 4/16/97 | 59 | 27 | 45.76% | 16 | 27.12% | 7 | 11.86% | 2 | 3.39% | 88.14% |
| 4/17/97 | 98 | 32 | 32.65% | 44 | 44.90% | 7 | 7.14% | 0 | 0.00% | 84.69% |
| 4/18/97 | 55 | 20 | 36.36% | 20 | 36.36% | 5 | 9.09% | 0 | 0.00% | 81.82% |
| 4/19/97 | 62 | 32 | 51.61% | 12 | 19.35% | 6 | 9.68% | 1 | 1.61% | 82.26% |
| 4/20/97 | 282 | 154 | 54.61% | 71 | 25.18% | 13 | 4.61% | 3 | 1.06% | 85.46% |
| 4/28/97 | 210 | 105 | 50.00% | 42 | 20.00% | 24 | 11.43% | 2 | 0.95% | 82.38% |
| 4/29/97 | 59 | 25 | 42.37% | 23 | 38.98% | 2 | 3.39% | 1 | 1.69% | 86.44% |
| 5/3/97 | 83 | 60 | 72.29% | 9 | 10.84% | 6 | 7.23% | 0 | 0.00% | 90.36% |
| 5/4/97 | 64 | 32 | 50.00% | 11 | 17.19% | 10 | 15.63% | 0 | 0.00% | 82.81% |
| 5/5/97 | 33 | 21 | 63.64% | 3 | 9.09% | 4 | 12.12% | 0 | 0.00% | 84.85% |
| 5/6/97 | 95 | 40 | 42.11% | 25 | 26.32% | 13 | 13.68% | 0 | 0.00% | 82.11% |
| 5/7/97 | 59 | 34 | 57.63% | 10 | 16.95% | 4 | 6.78% | 0 | 0.00% | 81.36% |
| Totals | 1459 | 750 | 51.41% | 328 | 22.48% | 123 | 8.43% | 12 | 0.82% | 83.14% |

Appendix B. Table 2. PIT-tagged wild steelhead trout interrogated at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Snake River trap.

| Date | Tagged | Granite | % | Little Goose | % | Low Mon. | % | McNary | % | Total % |
|---|---|---|---|---|---|---|---|---|---|---|
| 4/7/97 | 4 | 2 | 50.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 50.00% |
| 4/8/97 | 6 | 6 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/9/97 | 4 | 1 | 25.00% | 1 | 25.00% | 0 | 0.00% | 0 | 0.00% | 50.00% |
| 4/11/97 | 5 | 2 | 40.00% | 2 | 40.00% | 0 | 0.00% | 0 | 0.00% | 80.00% |
| 4/14/97 | 5 | 3 | 60.00% | 1 | 20.00% | 0 | 0.00% | 0 | 0.00% | 80.00% |
| 4/15/97 | 3 | 2 | 66.67% | 1 | 33.33% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/16/97 | 7 | 2 | 28.57% | 4 | 57.14% | 0 | 0.00% | 0 | 0.00% | 85.71% |
| 4/17/97 | 8 | 2 | 25.00% | 3 | 37.50% | 1 | 12.50% | 0 | 0.00% | 75.00% |
| 4/18/97 | 14 | 7 | 50.00% | 6 | 42.86% | 1 | 7.14% | 0 | 0.00% | 100.00% |
| 4/19/97 | 19 | 13 | 68.42% | 2 | 10.53% | 2 | 10.53% | 0 | 0.00% | 89.47% |
| 4/20/97 | 30 | 20 | 66.67% | 8 | 26.67% | 0 | 0.00% | 0 | 0.00% | 93.33% |
| 4/28/97 | 21 | 7 | 33.33% | 6 | 28.57% | 2 | 9.52% | 0 | 0.00% | 71.43% |
| 4/29/97 | 8 | 2 | 25.00% | 3 | 37.50% | 0 | 0.00% | 1 | 12.50% | 75.00% |
| 5/3/97 | 6 | 6 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 5/4/97 | 6 | 5 | 83.33% | 1 | 16.67% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 5/5/97 | 2 | 2 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| Totals | 148 | 82 | 55.41% | 38 | 25.68% | 6 | 4.05% | 1 | 0.68% | 85.81% |

Appendix B. Table 3. PIT-tagged hatchery steelhead trout interrogated at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Salmon River trap.

| Date | Tagged | Granite | % | Little Goose | % | Low Mon. | % | McNary | % | Total % |
|---|---|---|---|---|---|---|---|---|---|---|
| 4/14/97 | 98 | 47 | 47.96% | 20 | 20.41% | 8 | 8.16% | 0 | 0.00% | 76.53% |
| 4/15/97 | 41 | 20 | 48.78% | 8 | 19.51% | 4 | 9.76% | 0 | 0.00% | 78.05% |
| 4/16/97 | 73 | 42 | 57.53% | 14 | 19.18% | 4 | 5.48% | 1 | 1.37% | 83.56% |
| 4/17/97 | 103 | 57 | 55.34% | 19 | 18.45% | 11 | 10.68% | 0 | 0.00% | 84.47% |
| 4/18/97 | 109 | 59 | 54.13% | 17 | 15.60% | 16 | 14.68% | 0 | 0.00% | 84.40% |
| 4/19/97 | 90 | 47 | 52.22% | 18 | 20.00% | 8 | 8.89% | 0 | 0.00% | 81.11% |
| 4/25/97 | 59 | 27 | 45.76% | 7 | 11.86% | 11 | 18.64% | 0 | 0.00% | 76.27% |
| 4/28/97 | 42 | 16 | 38.10% | 5 | 11.90% | 3 | 7.14% | 0 | 0.00% | 57.14% |
| 5/2/97 | 108 | 58 | 53.70% | 16 | 14.81% | 6 | 5.56% | 0 | 0.00% | 74.07% |
| 5/3/97 | 121 | 56 | 46.28% | 18 | 14.88% | 13 | 10.74% | 0 | 0.00% | 71.90% |
| 5/4/97 | 98 | 47 | 47.96% | 22 | 22.45% | 5 | 5.10% | 0 | 0.00% | 75.51% |
| 5/5/97 | 101 | 54 | 53.47% | 20 | 19.80% | 7 | 6.93% | 0 | 0.00% | 80.20% |
| 5/6/97 | 105 | 45 | 42.86% | 19 | 18.10% | 12 | 11.43% | 0 | 0.00% | 72.38% |
| 5/7/97 | 104 | 52 | 50.00% | 10 | 9.62% | 10 | 9.62% | 0 | 0.00% | 69.23% |
| Totals | 1252 | 627 | 50.08% | 213 | 17.01% | 118 | 9.42% | 1 | 0.08% | 76.60% |

Appendix B. Table 4. PIT-tagged wild steelhead trout interrogated at Lower Granite, Little Goose, Lower Monumental, and McNary dams from the Salmon River trap.

| Date | Tagged | Granite | % | Little Goose | % | Low Mon. | % | McNary | % | Total % |
|---|---|---|---|---|---|---|---|---|---|---|
| 3/25/97 | 4 | 2 | 50.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 50.00% |
| 3/26/97 | 2 | 2 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 3/27/97 | 1 | 1 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 3/28/97 | 1 | 1 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/11/97 | 1 | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 0.00% |
| 4/14/97 | 1 | 1 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/15/97 | 1 | 1 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/17/97 | 1 | 1 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/18/97 | 6 | 5 | 83.33% | 1 | 16.67% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/19/97 | 5 | 3 | 60.00% | 2 | 40.00% | 0 | 0.00% | 0 | 0.00% | 100.00% |
| 4/25/97 | 4 | 2 | 50.00% | 1 | 25.00% | 0 | 0.00% | 0 | 0.00% | 75.00% |
| 4/28/97 | 6 | 4 | 66.67% | 1 | 16.67% | 1 | 16.67% | 0 | 0.00% | 100.00% |
| 5/2/97 | 5 | 3 | 60.00% | 0 | 0.00% | 2 | 40.00% | 0 | 0.00% | 100.00% |
| 5/3/97 | 4 | 3 | 75.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 75.00% |
| 5/4/97 | 3 | 1 | 33.33% | 0 | 0.00% | 1 | 33.33% | 0 | 0.00% | 66.67% |
| 5/5/97 | 2 | 1 | 50.00% | 0 | 0.00% | 1 | 50.00% | 0 | 0.00% | 100.00% |
| 5/6/97 | 4 | 2 | 50.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% | 50.00% |
| 5/7/97 | 8 | 5 | 62.50% | 1 | 12.50% | 0 | 0.00% | 0 | 0.00% | 75.00% |
| Totals | 59 | 38 | 64.41% | 6 | 10.17% | 5 | 8.47% | 0 | 0.00% | 83.05% |

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